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14. ABSTRACT

Background: There is a critical need to increase the racial/ethnic diversity of prostate cancer researchers. The goal of the Training Program is to provide research training activities to **12** students over a 3-year period from three Historically Black Colleges and Universities (HBCUs) in South Carolina: Claflin University, South Carolina State University, and Voorhees College. The three ***aims*** of the Training Program are: Aim 1.) To provide training in the basics of research design and methods to 4 Student Fellows each year from the three HBCUs; Aim 2.) To immerse 4 Student Fellows per year in prostate cancer research; Aim 3.) To implement a unique dual-level research mentoring strategy for the students. **Results:** During the current reporting period, 4 Student Fellows were identified, recruited to participate in the program, and admitted to the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program. The Student Fellows were matched with Research Mentors at MUSC, with whom they conducted research in the summer of 2014. Each Student Fellow prepared a scientific paper, gave a scientific presentation at the end of the summer program, and completed an 8-week Princeton Review Graduate Record Examination Test Preparation Course. In the summer of 2014, additional students at SCSU participated in summer program lectures via videoconference. **Conclusions:** State-of-the art comprehensive prostate cancer research education and training opportunities were provided to **4** Student Fellows from HBCUs in South Carolina. Each Student Fellow prepared a scientific paper and gave at least 1 scientific presentation. Six Student Fellows, two of whom were supported by leveraged funds, gave scientific presentations. A cadre of scientists who are well-prepared to conduct research spanning the continuum from basic science to clinical science to population-based research was developed.

15. SUBJECT TERMS

Prostate Cancer Research Training Program
Summer Undergraduate Research Program (SURP)
Student Fellows from Historically Black Colleges and Universities (HBCUs)

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INTRODUCTION

The Scientific Context of the Training Program

The South Carolina Collaborative Undergraduate HBCU Student Summer Training Program (referred to as the Training Program) will provide a biomedical research training experience to 12 students over a three-year period (2012-2015) from three Historically Black Colleges and Universities (HBCUs) – Claflin University (CU), South Carolina State University (SCSU), and Voorhees College (VC). Undergraduate students from the three HBCUs (defined as Student Fellows) will participate in research intensive summer internships in the laboratories/research units of senior prostate cancer research scientists at the Medical University of South Carolina Hollings Cancer Center (MUSC HCC). This Training Program builds upon the success of the previously funded Department of Defense (DOD) prostate cancer research training program (2009 - 2011) and the long standing NIH funded Summer Undergraduate Research Training Program at MUSC (1992 - present). The inter-institutional leadership of these summer training efforts have carefully examined the formative and summative evaluations provided by previous Student Fellows, Mentors, and Advisors in order to maximize the ability of this enhanced Training Program to reach its ultimate goal – to increase the racial and ethnic diversity of emerging scientists who may choose prostate cancer research careers in basic, clinical, and population sciences. The Training Program was improved by the inclusion of a built-in, dual-level research and career mentoring strategy involving current graduate students and post-doctoral trainees included on the mentoring team; the addition of a clinical shadowing experience in the MUSC HCC multidisciplinary genitourinary clinics and tumor board; more year-round opportunities for which the Student Fellows will participate; and an opportunity for Training Program alumni to continue relationships with new trainees going forward. Measurable outcomes of the Training Program will include the number of Student Fellows who take the Graduate Record Examination (GRE), apply to graduate school, and give scientific presentations and publish their research results in peer-reviewed scientific journals based on their summer research experience. Efforts are being made to capture long-term outcomes as well as to determine how many Student Fellows choose to pursue a medical or biomedical focused graduate and post graduate career.

The three Specific Aims are:

Aim 1. To provide training in the basics of research design and methods to 4 Student Fellows each year from the three HBCUs;

Aim 2. To immerse 4 Student Fellows per year in prostate cancer research;

Aim 3. To implement a unique dual-level research mentoring strategy for the students.

Program Director and Training Team

Dr. Marvella E. Ford is the Program Director. Drs. Omar Bagasra (CU), Judith Salley (SCSU), and Leroy Davis (VC) are Associate Directors. This four-person leadership team collaborates closely in the management and administration of the award, as well as the continued development and enhancement of the Training Program. The Program Director and Associate Directors share scientific interests in health disparities, serve in other leadership roles within their institutions, and meet frequently, both formally and informally. These individuals form the Executive Committee for the Training Program. Each institution has appointed Faculty Advisors consisting of Dr. Ewen McLean (CU), Dr. James B. Stukes (SCSU), and Mrs. Gayle Tyler Stukes (VC).

BODY

Statement of Work

Task 1. Identify and Recruit the Student Fellows

(a) Identify the pool of potential Student Fellows (Year 3, months 1-3)
(b) Interview the potential Student Fellows (Year 3, months 1-3)
(c) Select the top Student Fellows (Year 3, months 1-3)
(d) Match the Student Fellows with their Research Mentors at MUSC (Year 3, months 1-3)
(e) Hold the Kickoff Intensive and Luncheon (Year 3, months 4-6)

Deliverables: Four Student Fellows were identified, recruited to participate in the program, and matched with senior prostate cancer research mentors at MUSC.

Task 2. Provide Training in Biomedical and Prostate Cancer Research

(a) Conduct Aim 1: Training in the Basics of Research Design and Methods through participation in the MUSC Summer Undergraduate Research Program (Year 3, months 6-8)
(b) Conduct Aim 2: Prostate Cancer Research Training (Year 3, months 6-8)
(c) Sponsor the Student Fellows' Participation in a Graduate Record Examination (GRE) course (Year 3, months 6-8)

Deliverables: We provided state-of-the art comprehensive prostate cancer research education and training opportunities for 4 students from three of South Carolina's HBCUs. We have developed a cadre of scientists who are well-prepared to play a significant role in discovering and testing new prostate cancer biomarkers. These investigators will conduct research spanning the continuum from basic science to clinical science to population-based research. The Student Fellows are completing their junior or senior years of college and are continuing to take the GRE and apply to graduate or professional schools. We expect at least 75% of the Student Fellows to take the GRE and at least 75% of the Student Fellows will apply to graduate school.

Task 3. Prepare Tangible Scientific Products

(a) Prepare and present scientific abstracts based on the Student Fellows' prostate cancer research (Year 3, months 10-12)
(b) Prepare manuscripts that will be submitted to peer-reviewed journals (Year 3, months 10-12)
(c) Develop manuscripts to describe the scope and outcomes of the project (Year 3, months 9-12)

Deliverables: At least 6 scientific presentations were conducted by Student Fellows. At least 2 peer reviewed publications will result.

Task 4. Evaluate the Training Program

(a) Assess the number of applicants to the Training Program (Year 3, months 1-4)
(b) Assess the number of Student Fellows who apply to graduate school (Year 3, months 1-12)
(c) Assess the number of Student Fellows who are admitted to graduate school (Year 3, months 1-12)
(d) Assess the number of graduate schools to which Student Fellows are admitted (Year 3, months 1-12)
(e) Employ several tracking mechanisms to monitor the scientific progress of the students, including:
    1. Searching the MUSC graduate program databases to identify whether any of the students applied, were offered, or accepted positions at MUSC.
    2. Contacting the participating universities' alumni offices.
    3. Employing other internet-based search tools/communications (Google, Twitter, Facebook, and Historically Black College/University Connections, etc.) to identify students' current locations, contact information, and academic achievements (Year 2, months 10-12)
(f) Identify the number of scientific abstracts presented and peer-reviewed publications that result (Year 3, months 10-12)

Deliverables: We have published a peer-reviewed manuscript that describes the design of the Training Program and tangible products that have resulted from its implementation.

KEY RESEARCH ACCOMPLISHMENTS

Task 1. Identify and Recruit the Student Fellows

(a) **Identify the pool of potential Student Fellows (Year 3, months 1-3)**

(b) **Interview the potential Student Fellows (Year 3, months 1-3)**

(c) **Select the top Student Fellows (Year 3, months 1-3)**

To accomplish Tasks 1(a) – 1(c), Dr. Ford, the Program Director worked with Associate Directors Dr. Rebecca Bullard-Dillard and her replacement upon leaving CU, Dr. Omar Bagasra (CU), Dr. Judith Salley (SCSU), and Dr. Leroy Davis (VC) as well as Faculty Advisors Dr. Ewen McLean (CU), Dr. James Stukes (SCSU), and Mrs. Gayle Stukes (V) to identify potential Student Fellows. The Associate Directors and Faculty Advisors issued a call for applicants to their student bodies and personally approached students whom they felt would be outstanding applicants for the summer research program.

For example, to broaden the pool of potential applicants, each Associate Director invited faculty and students from his/her institution to participate in the Ernest Just Symposium held on February 28, 2014 at MUSC. A total of 251 students participated, including 56 students from HBCUs in South Carolina. The 251 students represented 18 different colleges and universities. A total of 56 students from HBCUs in SC participated in the Symposium, as well as 76 students from HBCUs in other regions of the country. Dr. Salley was instrumental in recruiting HBCU students from across the U.S. The students who participated in the Symposium also received a tour of scientific research units at MUSC and met with MUSC faculty members who could become their future research mentors. The agenda and the number of students from each institution are included in **Appendices A-B.**

(d) Match the Student Fellows with Their Research Mentors at MUSC (Year 3, months 1-3)

In year 3, the Student Fellows were matched with their Research Mentors at MUSC based on the expressed interests of the Student Fellows as stated in their written MUSC Summer Undergraduate Research Program (SURP) applications. The following table shows the names of the students who participated in the 2014 DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program, their Research Mentors at MUSC, and their research topics.

Summer 2014 DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program Students, Mentors, and Research Topics

Student Name	Academic Institution	MUSC Research Mentor	Research Topic
Ms. Casseanna Holmes	Voorhees College	David P. Turner, PhD	Targeting RAGE Expression in Breast Cancer
Ms. Franshawn Mack (Dual Year Participant 2013/2014)	SC State University	Marvella E. Ford, PhD	Evaluating the Prevalence of Overweight/Obesity and Physical Activity in a Diverse Sample of South Carolina Breast Cancer Survivors
Ms. Khaalida Poindexter	SC State University	Victoria Findlay, PhD	miRNA-510 as a Non-Invasive Biomarker in Triple Negative Breast Cancer
Mr. Jagreet Singh	Claflin University	Shikhar Mehrotra, PhD	Antioxidant Capacity Of MDSCs: Potential Target For Immunotherapy

In addition to the students listed above, the Director and Associate Directors leveraged funding from two other grants and funding sources to support an additional two students **(Appendix C)**.

(e) Hold the Kickoff Intensive and Luncheon (Year 3, months 4-6)

The Kickoff Intensive and Luncheon took place during the first meeting of the didactic training program in prostate cancer research. A small group meeting was held with the Student Fellows to introduce them to the internal training team, and review the student handbook. The student handbook was developed to provide the students with a detailed resource that describes the infrastructure of the training program as well as the expectations of the students. Ms. Tonya Hazelton, who coordinates the DOD Training Program, gave an overview of the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program.

Task 1 Deliverables: Four Student Fellows (plus an additional two students who were supported using leveraged funds) were identified, recruited to participate in the program, and admitted to the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program. The Student Fellows were matched with Research Mentors at MUSC, with whom they conducted research in the summer of 2014.

Task 2. Provide Training in Biomedical and Prostate Cancer Research

(a) Conduct Aim 1: Training in the Basics of Research Design and Methods through participation in the MUSC Summer Undergraduate Research Program (Year 3, months 6-8)

The Student Fellows participated in an intensive training program in the Basics of Research Design and Methods through participation in the MUSC Summer Undergraduate Research Program (SURP). The following table shows the SURP curriculum from 2014.

Summer Undergraduate Research Program CGS 761 Lecture Series, Summer 2014
8:30-9:30 AM (unless otherwise noted)

Date	***Topic***	***Lecturer***
May 27	**MANDATORY**: Introduction to the Summer Program **ROOM BSB 402**	Cynthia Wright, PhD
May 28	Transcription **ROOM BSB 402**	Steven Kubalak, PhD
May 29	Example of Translational Research: Thromboxane Receptors in Bladder Cancer **ROOM BSB 402**	Perry Halushka, PhD, MD
May 30	Human Subject Protection	Susan C. Sonne, PharmD
	SCTR SUCCESS Center: Scientist Support for Conducting Research **ROOM BSB 402**	Stephanie Gentilin, MA, CCRA

MANDATORY - All Responsible Conduct of Research Sessions - LOCATION BSB 100

June 2	**9-9:50am MANDATORY***:* Responsible Lab Citizenship & Mentoring (lecture/discussion) **9:50-10am** - - - Break- - - **10-10:50am** Data Management/Data Manipulation (lecture/case/study/discussion) **ROOM BSB 202**	Ed Krug, PhD
June 3	**8:30-9:30am MANDATORY***:* Public Perceptions of Scientific Research ("And the Band Played On") **9:30-9:40am** - - -Break- - - **9:40-10:20am** Questionable Research Practices (discussion of video) **ROOM BSB 202**	Ed Krug, PhD
June 4	**8:30-9:20am Mandatory:** Moral Reasoning in Ethical Dilemmas (lecture/case study/discussion) **9:20-9:30am - - -**Break- - - **9:30-10:20am** Animal Use in Research (lecture & discussion) **ROOM BSB 202**	Ed Krug, PhD Alison Smith, DVM
June 5	**8:30-9:20am MANDATORY*:*** Authorship and Plagiarism (lecture/case study/discussion) **9:20-9:30am** - - -Break- - - **9:30-10:10am** Research Misconduct/Whistleblower Protections (lecture/case study/discussion) **10:10-10:20am** Closing Comments/Exit Evaluation **ROOM BSB 202**	Ed Krug, PhD

Outside Assignment: Complete the University of Montana On-Line RCR training (link below) - you must score a minimum of 70% on all quizzes. Submit paper copies of quiz completion to Stephanie Brown-Guion (BE101F) **no later than 4 PM Friday, June 13**
(http://ori.dhhs.gov/education/products/montana_round1/research_ethics.html)

NOTE: The schedule on the following pages is color-coded. Lectures in the Black font are required of everyone. You must select a lecture track for the remainder of the summer. Your choices are Cardiovascular (blue font), Cancer (red font), Oral Health Sciences (pink font), and Neuroscience (green font). If you are part of the MBHS group, your lectures are attached at the end of this schedule.

Lecture Time: 8:30-9:30; Location: 100 BSB (unless otherwise noted)

Date	***Topic***	***Lecturer***
June 6	Hepatic Steatosis in a Growing World: The Impact On Transplantation **ROOM BSB 202**	Kenneth Chavin, MD, PhD
June 9	Lipidomics **ROOM BSB 202**	Ashley Cowart, PhD
June 10	(C) Cytogenetics Daynna Wolff, PhD	
June 11	Cell Biology – Tissue Ultrastructure **ROOM BSB 202**	Debra Hazen-Martin, PhD
June 12	Developmental Biology **ROOM BSB 202**	Michael Kern, PhD

June 13	Recombinant DNA **ROOM BSB 202**	David Kurtz, PhD
June 16	Proteomics Technology **ROOM BSB 202**	Lauren Ball, PhD
June 17	(C) Cancer Cell Cycle **ROOM BSB 202**	Cynthia Wright, PhD
June 18	Microarray Analysis **ROOM BSB 202**	Jeremy Barth, PhD
June 19	(D) Tooth Development – **ROOM BSB 252**	Michael Kern, PhD
June 20	Confocal/Multiphoton Microscopy of Living Cells And Tissues **ROOM BSB 202**	John Lemasters, MD,PhD
June 23	(H) Atherosclerosis **ROOM BSB 202**	Samar Hammad, PhD
June 24	(H) Electrical Properties of the Heart **ROOM BSB 202**	Rupak Mukherjee, PhD
June 25	(C) Kinds of Cancer **ROOM BSB 202**	Robert Gemmill, PhD
June 25	(D) Temporomandibular Joint Biomechanics – **BSB 252**	Hai Yao, PhD
June 26	(N) Retinoids & Vision **ROOM BSB 202**	Masahiro Kono, PhD
June 27	Receptors **ROOM BSB 202**	Steven Rosenzweig,PhD
June 30	G Proteins **ROOM BSB 202**	John Hildebrandt, PhD
July 1	(N) Dementia **ROOM BSB 202**	Mark Kindy, PhD
July 2	(N) ADD/ADHD	Antonieta Lavin, PhD Jonathan Dilgen, PhD
July 3	(H) The Heart **ROOM BSB 202**	Perry Halulshka, PhD, MD
July 7	Stem Cells	Amanda LaRue, PhD
July 8	(N) Spinal Cord Injury	Narendra Banik, PhD
July 8	(D) Salivary Diagnostics – **ROOM BSB 252**	Visu Palanisamy, PhD
July 9	(H) Aspirin & NSAIDS	Perry Halushka, PhD, MD
July 9	(D) Overview of Dentistry & Dental Materials – **ROOM BSB 252**	Joe Vuthiganon, DMD
July 10	(C) Smoking & Cancer	Michael Cummings, PhD
July 10	(D) Periodontal Disease – **BSB 252**	Heidi Steinkamp & Keith Kirkwood, DDS, PhD
July 11	(D) ****Oral Pharyngeal Cancer – **BSB 252**	Boyd Gillespie, MD
July 14	(C) Epidemiology of Cancer	Kristen Wallace, PhD
July 15	(H) Arterial Pressure Control & High Blood Pressure	Perry Halushka, PhD, MD
July 15	(C) Cancer Chemotherapy	David Kurtz, PhD
July 15	(D) Oral Infections – **BSB 252**	Caroline Westwater, PhD
July 16	(N) Neuroimaging Lab Demonstration	Colleen Hanlon, PhD
July 17	(H) Renal Regulation of Homeostasis	Ed Soltis, PhD
July 18	(H) Imaging the Heart	Joseph Schoepf, MD
July 21	(D) Craniofacial Anomalies – **BSB 252**	Carlos Salinas, DMD
July 22	(N) Addiction & Alcohol	Corrigan Smothers, PhD
July 23	(C) Cancer Disparities	Marvella Ford, PhD
July 23	(N) Your Brain, Stress, and Anxiety	Arthur Riegel, MD
July 23	(D) Oral Health Community Engagement – **BSB 252**	Renata Leite, DDS
July 24	(N) Addiction & Drugs	Patrick Mulholland, PhD

Key: Black – mandatory for everyone
Red or (C) – Cancer track
Blue or (H) – Cardiovascular track
Green or (N)– Neuroscience track
Pink (D) – Craniofacial Biology
***Lecture will be held at 8:00am-9:am

MANDATORY PRESENTATIONS:

July 29 – July 31st 2014 ROOM BSB 100

Conduct Aim 2: Prostate Cancer Research Training (Year 3, months 6-8)

The Student Fellows in the Training Program participated in an intensive 10-week training program in Prostate Cancer Research. Lectures focused on population science, statistical methods in prostate cancer research, prostate cancer clinical research, and basic science research. Other lectures described funding opportunities available to the students, career development opportunities, qualitative research methods, perspectives of prostate cancer among community members, and tips for preparing graduate school applications. In addition, as prostate cancer is a hormone-related cancer and some of the biological mechanisms that influence the etiology and treatment of prostate cancer are also relevant to breast cancer, the curriculum included information pertaining to breast cancer as well.

The Training Program schedule also provided time for students to rehearse their research presentations and gain input from their mentors and other scientists at the HCC. Disparities research was a cross-cutting theme in all of the lectures.

The structure of the curriculum also provides the students with a better understanding of the different population groups that were included in their research. Therefore, cultural enrichment activities were added to the curriculum, such as the Gullah tour of Charleston, in order to expose the students to the local and historic culture of the Charleston population. The Sea Island (Gullah) population is a subpopulation of African Americans indigenous to the coastal regions of the eastern seaboard. They are one of the most genetically homogeneous groups of blacks in the U.S. Their particularly low rate of European American genetic admixture makes this a unique population for basic, clinical and population-based research. The following table shows the cancer research training curriculum for 2014.

2014 BREAST AND PROSTATE CANCER
SUMMER UNDERGRADUATE RESEARCH TRAINING CURRICULUM
May 26, 2014-August 1, 2014
11:00a.m.-12:00p.m.

Week	Topic	Instructor	Location and Date
WEEK 1	Welcome and Overview of the Training Program	**Leadership, Mentors and Planning Team**	**Thursday, May 29, 2014 BE103E**
WEEK 2 (Basic Science Lecture)	Breast Health and Breast Disease, The Basics	**Rita Kramer, M.D. Associate Professor Hematology / Oncology**	**Tuesday, June 3, 2014 DD 312**
WEEK 2 (Basic Science Lecture)	Genetic Basis of Cancer	**Dennis Watson, Ph.D Professor Pathology & Laboratory Medicine**	**Thursday, June 5, 2014 DD 312**
WEEK 3 (Clinical Science Research Lecture)	Anatomy and the Function of the Prostate	**Harry S. Clarke, M.D., Ph.D Professor Urology Services**	**Monday, June 9, 2014 BE 103E**
WEEK 3 (Clinical Science Research Lecture)	Controversies in Breast Cancer Screening	**Madelene Lewis, M.D. Assistant Professor Radiology**	**Tuesday, June 10, 2014 EL 104**
WEEK 3 (Cultural Enrichment)	Cultural Enrichment Event	**Cultural Enrichment Event (ALL DAY)**	**Thursday June 12, 2014**
WEEK 4 (Clinical Science Research Lecture)	Controversies in Prostate Cancer Screening	**Jonathan Picard, M.D. Assistant Professor Urology Services**	**Tuesday, June 17, 2014 DD 312**
WEEK 4 (Academic Planning Lecture)	Funding Opportunities for Underrepresented Minority Scholars	**Joann F. Sullivan, Ph.D Assistant Dean for Extramural Program Development**	**Tuesday June 19, 2014 DD 312**
WEEK 5 (Basic Science Lecture)	Receptor Crosstalk Leading To Cancer Cell Invasion	**Steven Rosenzweig, Ph.D Professor Pharmacology**	**Tuesday, June 24, 2014 DD 312**
WEEK 5 (Biostatistical Methods Lecture)	Biostatistical Issues in Breast and Prostate Cancer Research	**Elizabeth Garrett-Mayer, Ph.D Professor Public Health Sciences**	**Thursday June 26, 2014 DD 312**
WEEK 6 (HCC Outreach Lecture)	Hollings Cancer Center Outreach Mobile Unit & Community Compass	**Debbie Bryant, DNP, RN Assistant Director Cancer Outreach**	**Tuesday July 1, 2014 DD 312**
WEEK 6 (Research Lecture)	Tissue Biorepository	**Kiwana Gibbs, MA Operations Manager of Tissue Biorepository and Analysis**	**Thursday July 3, 2014 DD 312**
WEEK 7 (Cultural Enrichment)	Cultural Enrichment Event	**Cultural Enrichment Event (ALL DAY)**	**Tuesday, July 8, 2014**
WEEK 7 (Tips for Preparing Graduate School Applications)	Improving Graduate School Admission Rates	**Cynthia F. Wright, Ph.D Associate Dean for Admissions and Career Development**	**Thursday July 10, 2014 BE402 *New Location Start***
WEEK 8 (Population Science Research Lecture)	Community-Based Genetic Research Project Among The Sea Islanders (Gullahs) In SC	**Ida J. Spruill, Ph.D Assistant Professor College of Nursing**	**Tuesday, July 15, 2014 BE402**
WEEK 8: Special Lecture	Introduction to Public Health	**John Vena Professor and Founding Chair Department of Public Health**	**Thursday July 17, 2014 BE 402**
WEEK 8 (Population Science/Epidemiologic Research Lecture)	Epidemiologic Issues in Prostate Cancer Research	**Anthony Alberg, Ph.D Professor Cancer Control Program**	**Thursday July 17, 2014 BE 402**
WEEK 9 (Clinical Research Lecture)	Vitamin D and Prostate Cancer	**Sebastiano Gattoni-Celli, M.D. Professor Radiation Oncology**	**Tuesday July 22, 2014 BE 402**
WEEK 9 (Population Science Research Lecture)	Survivorship Issues in Breast Cancer	**Katherine Sterba, PhD Assistant Professor Cancer Control Program**	**Tuesday July 24, 2014 BE 402**
WEEK 10 (HCC Outreach Lecture)	Cultural Competency	**AHEC Video**	**Thursday July 29, 2014 BE402**
WEEK 10 (Rehearsals)	Research Presentation Rehearsals	**All Research Students and mentors**	

CORE LECTURE **BREAST CANCER LECTURE** **PROSTATE CANCER LECTURE**

***(c)* Sponsor the Student Fellows' Participation in a Graduate Record Examination (GRE) course (Year 3, months 6-8)**

In 2014, all 4 Student Fellows took the 10-week Princeton Review GRE Test Preparation Course. The Princeton Review is a standardized test preparation company. The course met on Wednesday evenings from 5:30 pm – 8:30 p.m. The course seamlessly adjusts classwork and homework to the skill level of each student. This is accomplished by focusing on the areas where each student needs the most improvement. The course provides instruction in test-taking skills, and provides opportunities for dynamic group discussions and collaborative drills.

Task 2 Deliverables: In 2014, state-of-the art comprehensive prostate cancer research education and training opportunities were provided for **4** students from three of South Carolina's HBCUs. Funds were leveraged from other federally funded training grants and funding sources to provide the same level of education and training to an additional **2** students from HBCUs in South Carolina. We are developing a cadre of scientists who are well-prepared to play a significant role in discovering and testing new prostate cancer biomarkers. In the future, these investigators will likely conduct research spanning the continuum from basic science to clinical science to population-based research.

Task 3. Prepare Tangible Scientific Products

(*a*) Prepare and present scientific abstracts based on the Student Fellows' prostate cancer research (Year 3, months 10-12)

***(b*) Prepare manuscripts that will be submitted to peer-reviewed journals (Year 3, months 10-12)**

***(c)* Develop manuscripts to describe the scope and outcomes of the project (Year 3, months 9-12)**

In 2014, each Student Fellow prepared a scientific research paper that will form the basis of a peer-reviewed publication. Each Student Fellow also gave a scientific presentation based on the results of his or her work.

Summaries of each Student Fellows' research projects are included in **Appendix D**. Please note that the biological mechanisms that are included in the Student Fellows research have direct relevance/application to prostate cancer research. A manuscript describing the scope and outcomes of the Training Program will be initiated in the fall of 2014.

Deliverables: A total of 6 scientific presentations were made by the DoD Student Fellows plus 2 additional Student Fellows who were supported through leveraged funds. A manuscript describing the scope and outcomes of the Training Program was published in the Journal of Cancer Education in spring 2015 (**Appendix F)**.

Task 4. Evaluate the Training Program

***(a)* Assess the number of applicants to the Training Program (Year 3, months 1-4)**

In the spring of 2014, 8 students from South Carolina's HBCUs applied to the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program. As planned, four Student Fellows were selected who were funded through the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program. An additional 2 Student Fellows were selected. Their participation in the Training Program was supported through leveraged funds from a NIH/NCI grant and MUSC HCC funds.

***(b)* Assess the number of Student Fellows who apply to graduate school (Year 3, months 1-12)**

The Student Fellows who participated in the 2014 DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program were rising sophomores through seniors. As described below, we are employing several strategies to monitor the Student Fellows' progression through their academic careers.

(c) **Assess the number of Student Fellows who are admitted to graduate school (Year 3, months 1-12) and**

(d) **Assess the number of graduate schools to which Student Fellows are admitted (Year 3, months 1-12)**

We are actively keeping track of the progress of the Student Fellows using the strategies that are described below.

(e) **Employ several tracking mechanisms to monitor the scientific progress of the students, including:**

1. **Searching the MUSC graduate program databases to identify whether any of the students applied, were offered, or accepted positions at MUSC.**
2. **Contacting the participating universities' alumni offices.**
3. **Employing other internet based search tools/communications (Google, Twitter, Facebook, and Historically Black College/University Connections, etc.) to identify students' current locations, contact information, and academic achievements (Year 3 and beyond)**

We have implemented several steps for tracking student scientific progress. Communication and assistance from the Associate Directors and Faculty Advisors have proved to be very effective. Additionally, social media tools such as Facebook have also been useful for engaging the students and opening a venue for communication. Another method we have found useful is text messaging. We have found that students respond more quickly to text messages than to emails and telephone calls. We will utilize and build upon these methods to improve continued student tracking. These multiple tracking strategies will be used to update the table that is included in **Appendix E**, which lists the academic accomplishments of the Student Fellows.

(f) **Identify the number of scientific abstracts presented and peer-reviewed publications that result (Year 3, months 10-12)**

The Student Fellows gave a total of 6 scientific presentations. The mentors of the Student Fellows have confirmed that manuscripts that include some of the Student Fellows as co-authors are underway.

Deliverables: The Student Fellows are completing their junior or senior years of college and are continuing to apply to graduate or professional schools. One student who received support from leveraged funding, Bobbie Blake, was accepted into the Master's in Biotechnology Program at Claflin University. The Student Fellows gave a total of 6 scientific presentations. Also, each year, we asked the Student Fellows to evaluate the Training Program. The results from the 2014 Student Fellows are presented in the following table.

SUMMARY RESULTS OF STUDENT EVALUATIONS 2014 (n=6)

Survey Item	Strongly Disagree		Disagree		Not Sure		Agree		Strongly Agree	
	N	%	N	%	N	%	N	%	N	%
1. Overall, the summer program was a good research experience.	0	0.0	0	0.0	0	0.0	**1**	**16.7**	**5**	**83.3**
2. The summer program helped me learn the fundamentals of breast and prostate cancer and research.	0	0.0	0	0.0	0	0.0	**1**	**16.7**	**5**	**83.3**
3. The Princeton Review Graduate Record Examination (GRE) Course was effective in helping me to learn GRE test preparation strategies.	0	0.0	0	0.0	0	0.0	**3**	**50.0**	**3**	**50.0**
4. The seminar schedule was convenient.	0	0.0	0	0.0	0	0.0	**3**	**50.0**	**3**	**50.0**
5. The seminar topics were of interest to me.	0	0.0	0	0.0	0	0.0	**5**	**83.3**	**1**	**16.7**
6. Participating in the program helped to strengthen my desire for a career in cancer research.	0	0.0	0	0.0	**1**	**16.7**	**2**	**33.3**	**3**	**50.0**
7. The Program Director (Dr. Ford) was accessible and assisted me when needed.	0	0.0	0	0.0	0	0.0	0	0.0	**6**	**100.0**
8. The Program Assistant (Ms. Heidi Varner) was accessible and assisted me when needed.	0	0.0	0	0.0	0	0.0	0	0.0	**6**	**100.0**
9. My research mentor was accessible and assisted me when needed.	0	0.0	0	0.0	0	0.0	**1**	**16.7**	**5**	**83.3**
10. I would recommend this program to other students at my college/university.	0	0.0	0	0.0	0	0.0	0	0.0	**6**	**100.0**

REPORTABLE OUTCOMES

Student Summer Research Summaries

Each Student Fellow prepared a research paper and gave a scientific presentation to his/her peers, mentors and other faculty at MUSC. Details regarding the manuscripts and scientific presentations developed by the Student Fellows are included in **Appendix D**.

CONCLUSIONS

During the past year of funding of the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program, the tasks outlined in the Statement of Work were successfully met. Four Student Fellows were recruited from CU, SCSU, and VC. Each Student Fellow conducted research and prepared a research paper that was presented at the conclusion of the program. Some Student Fellows are expected to be included as co-authors on future peer-reviewed scientific publications, based on their summer research.

As shown in **Appendix C**, two additional students participated in the DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program using funds leveraged from a NIH/NCI grant and MUSC HCC funds.

2014 Annual Report Appendices

Appendix A: 2014 Ernest E. Just Symposium Agenda

ERNEST E. JUST

Ernest Everett Just (1883–1941) was born and raised in a family of dockworkers in Charleston, SC. He left to prepare for college at the Industrial School of State College in Orangeburg and the Kimball Hall Academy, NH. Subsequently, he graduated in 1907 from Dartmouth College, magna cum laude, Phi Beta Kappa, with honors in botany, history, and sociology. That same year, Dr. Just accepted a teaching post at Howard University, where he later advanced to the rank of full professor and head of the Department of Physiology. In 1909, he served as a summer research assistant at the Marine Biological Laboratory at Woods Hole, MA. In 1915, his research attracted the attention of the National Association of the Advancement of Colored People, who conferred upon him the first Spingarn Medal, an annual prize given to an outstanding African-American. In 1916, Ernest Just received his PhD in experimental embryology, magna cum laude, from the University of Chicago, with a dissertation on the mechanics of fertilization. In 1919, he worked at the marine biological laboratories in Naples and Sicily.

Dr. Just's achievements earned him the role of adjunct researcher at the Kaiser Wilhelm Institute fur Biologie in Berlin-Dahlem (1920–1931) as the Julius Rosenwald Fellow in Biology of the National Research Council. A gift from the Rosenwald Fund to Just for $80,000 annually for several years offered him protected time for research and graduate teaching. So significant was his work that several of the crowned heads of Europe offered him use of their laboratories.

Dr. Just eventually returned to Woods Hole, where he spent almost twenty years at the research bench. In 1924, he was selected by leading German biologists to write a treatise on fertilization, one of a series of monographs by experts on cell structure and function.

Dr. Just coauthored General Cytology (published in 1924) and contributed to a series on colloid chemistry. He was vice president of the American Zoological Society, a member of the Ecological Society, National Research Council, and La Societe Nationale Des Sciences Naturelles Et Mathematiques, the founder of Omega Psi Phi and faculty advisor at Howard University (1911); Editor of Protoplasm, Biological Zoology, and Physiological Zoology; and a collaborator for Cytologia. In 1930, Dr. Just lectured at the 11th International Congress of Zoologists, Padua, Italy, basing his talk on his fifty published papers. In 1936, he spent three years on The Biology of the Cell Surface, a book summarizing his scientific observations. In 1939, early in WWII, Dr. Just was captured in France by Germans and held briefly in a prisoner-of-war camp. In 1940, he returned to the U.S. planning to resume teaching at Howard University. Unfortunately, an illness, which proved to be cancer, intervened and Dr. Just succumbed to his disease in 1941.

Thank you to our Sponsors:

MUSC Dept. of Regenerative Medicine, College of Graduate Studies, Office of the Provost, SC EPSCoR/IDeA, SC NASA Space Grant Consortium, College of Dental Medicine, College of Health Professions, College of Medicine, College of Pharmacy, College of Nursing, Avery Research Center for African American History and Culture (College of Charleston), U.S. Department of Energy, MUSC Public Information Community Outreach, MUSC Hollings Cancer Center, NIH/NCI P20 SC CaDRe Grant

For more information contact:
Dr. Titus Reaves reaves@musc.edu
Phone: 843-876-2411 **Website: http://academicdepartments.musc.edu/grad/ernestjust/**

Ernest E. Just Scientific Symposium
Medical University of South Carolina

February 28, 2014
110 Drug Discovery Auditorium

MUSC
MEDICAL UNIVERSITY
of SOUTH CAROLINA

8:00-9:00 am	**Registration and Breakfast** Drug Discovery Lobby
9:00-9:10 am	**Opening** **Mark Sothmann, Ph.D., Interim President** **Vice President for Academic Affairs and Provost, MUSC** **Etta D. Pisano, M.D., Dean, College of Medicine** **Vice President for Medical Affairs, MUSC** **Greeting** **Stephen Lanier, Ph.D. Associate Provost for Research** **Professor of Pharmacology, MUSC** **Jacqueline McGinty, Ph.D.** **Interim Dean, College of Graduate Studies** **Professor of Neuroscience, MUSC**
9:10-9:50 am	***"The Importance of the Liberal Arts in a Scientific Education and Career"*** **Stephon H.S. Alexander, Ph.D.** The Ernest E. Just 1907 Professor of Natural Sciences Director of the Ernest E. Just Program Associate Professor of Physics and Astronomy Dartmouth College
9:50 – 10:40 am	**Just Symposium Keynote Speaker** ***"Understanding Racial Group and Education Differences in Obesity"*** **James Jackson, Ph.D.** Director, Institute for Social Research Daniel Katz Distinguished Professor of Psychology University of Michigan
10:40 – 11:00 am	**BREAK**
11:00 – 11:20 am	***"Genetic and Environmental Factors Leading to Lupus in the South Carolina Gullah Population"*** **Sybil Prince-Nelson, Ph.D. Candidate** Department of Public Health Sciences Medical University of South Carolina

Boris Hinz, Ph.D.

Dr. Hinz received his Ph.D. in Cell Biology and Theoretical Biology from the University of Bonn in Germany. Dr. Hinz is an Associate Professor at the Matrix Dynamics Group, Faculty of Dentistry at the University of Toronto and cross-appointed Professor with the Faculty of Medicine, Department of Surgery and the Institute of Biomaterials and Biomedical Engineering at the University of Toronto. From 1999 to 2002, he was a postdoctoral fellow of Dr. Giulio Gabbiani, Department of Experimental Pathology, Centre Medical Universitaire, University of Geneva, Switzerland. Dr. Hinz then moved on to lead a research group at the Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, joining the worlds of Cell Biology, Biophysics, and Bioengineering. In 2006, he was nominated Maître d'enseignement et de recherche (Assistant Professor level). Dr. Hinz is Past President and Board Member of the European Tissue Repair Society, Secretary and founding member of the Canadian Connective Tissue Society, Associate Editor of the journal *Wound Repair and Regeneration* and Associate Member of the Faculty of 1000. Dr. Hinz's research aims are to understand the role of contractile myofibroblasts in physiological tissue repair and in causing pathological tissue fibrosis.

Joan S. Brugge, Ph.D.

Dr. Brugge is currently the Chair of the Department of Cell Biology and Co-Director of the Ludwig Center at Harvard Medical School. She joined the faculty of the Harvard Medical School as a Professor in July 1997. A graduate of Northwestern University, she did her graduate work at the Baylor College of Medicine, completing her PhD in 1975. She then performed her postdoctoral training at the University of Colorado with Dr. Raymond Erikson. Dr. Brugge has held full professorships at the State University of New York, Stony Brook, and the University of Pennsylvania, where she was also named as an investigator at the Howard Hughes Medical Institute. From 1992-1997, Dr. Brugge was Scientific Director of the biotechnology company ARIAD. She then joined the HMS faculty in 1997 as the Louise Foote Pfeiffer Professor of Cell Biology; became the Chair of Cell Biology in 2004; and was appointed Co-Director of the Ludwig Center at Harvard in 2014.

Sybil Prince-Nelson Ph.D. Candidate

Ms. Prince-Nelson received her bachelor's degree in Mathematics and Music from Washington and Lee University in Lexington, Virginia. She then received her Master of Science degree in Mathematics and the title of her thesis was "Dynamics of nearly circular Vortex Filaments". Currently, she is a Ph.D. candidate in the Department of Public Health Sciences and graduates in May 2014. Mrs. Prince-Nelson's research interests are in random forests, methodological issues in logic regression and classification and regression tree analysis and statistical genetics. Mrs. Prince-Nelson was invited to speak at Proctor and Gamble in Cincinnati, Ohio. The title of her talk was "*Logic: An Extension of Logic Regression*". Mrs. Prince-Nelson placed second at the 2013 Perry V. Halushka MUSC Student Research Day. Her presentation title was "A Method for Predicting Disease Outcome".

Jennifer West, Ph.D.

Dr. West received her Ph.D. from University of Texas at Austin in Austin, Texas. Upon completion of her doctorate, she spent time at the California Institute of Technology as a postdoctoral fellow. Dr. West stands as a true pioneer in the development of polymeric biomaterials with applications ranging from targeted cancer therapeutics to vascular grafts. She holds 15 patents, which are licensed with 8 different companies. Dr. West has been recognized for numerous awards, honors and distinctions. In 2006, she received the Quantum Award from the National Institute for Biomedical Imaging and Bioengineering at National Institute of Health. In 2010, Dr. West was recognized as the Inventor of the Year in an award from the State Bar of Texas. Her research interests are in biomaterials, nanotechnology and tissue engineering involving the synthesis, development, and application of novel biofunctional materials, and the use of biomaterials and engineering approaches to study biological problems. Dr. West has over 140 publications in her research area.

11:20 – 12:00 pm **The E.E. Just Undergraduate Excellence in Research Presentations**

"G-Protein Coupled Receptor Kinase 5 Knockdown Sensitizes Prostate Cancer Cells to Docetaxel Treatment"
Ms. Cassie Hobbs
Florida A& M University
1st Place Recipient of The E.E. Just Undergraduate Award for Excellence in Research

"Effects of Polycyclic Aromatic Hydrocarbons in MDA-MB-231 Cells"
Ms. Joycelyn Smith
Benedict College
2nd Place Recipient of The E.E. Just Undergraduate Award for Excellence in Research

"Representation of Black Men in Randomized Control Clinical Trials from 1992-2011"
Mr. Michael Dumas
Florida A&M University
3rd Place Recipient of The E.E. Just Undergraduate Award for Excellence in Research

12:00 - 3:00 pm **BREAKOUT SESSIONS/LUNCH**
Campus tours for visiting students
Undergraduate Advisors meet with MUSC College Admissions Officers (Drug Discovery Bldg Rm 111)

BREAKOUT SESSIONS
Visiting students meet with MUSC College Admissions Officers:
College of Graduate Studies: Dr. Cynthia Wright – Bioengineering Building Room 112
College of Medicine: Myra Haney Singleton and Wanda Taylor – Basic Science Building Room 100
College of Dental Medicine: Cindy Oliver and Pearl Givens – Basic Science Building Room 451
College of Pharmacy: Christine Faye Ratliff – Pharmacy Building Room QF 302B
College of Nursing: Dr. Ida Johnson-Spruill – College of Health Professions Building A Room 102A
College of Health Professions: Lauren Smith and Cami Taylor – College of Health Professions Building A Room 201

1:00-1:50 pm ***"Biomimetic Microfabrication to Manipulate Cells"***
Jennifer West, Ph.D.
Fitzpatrick Family University Professor of Engineering
Duke University of School of Medicine

2:00-2:50 pm ***"Mechanics and Fibrosis"***
Boris Hinz, Ph.D.
Associate Professor Matrix Dynamics Group
Faculty of Dentistry
University of Toronto

3:00-3:50 pm ***"Modeling Morphogenesis, Tumorigenesis and Drug Sensitivity in 3D Cultures"***
Joan Siefert Brugge, Ph.D.
Chair and Professor of Cell Biology
Professor, Department of Experimental Therapeutics
Harvard Medical School

Stephon Alexander, Ph.D.

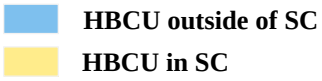
Dr. Stephon Alexander received his Ph.D. in Physics from Brown University in Providence, Rhode Island. Dr. Alexander held postdoctoral fellowships at Imperial College, London and The Stanford Linear Accelerator Center in Menlo Park, California. Dr. Alexander is a theoretical physicist specializing in the interface between cosmology, particle physics and quantum gravity (String Theory and Loop Quantum Gravity). He is currently the Ernest Everett Just 1907 Professor of Natural Sciences. Dr. Alexander has lectured at the Annual International Society of Young Astronomers Winter School (Haverford College and Dartmouth College) on Graduate General Relativity, Undergraduate General Relativity, Quantum Physics History of Science, Graduate Level and Advanced Quantum Mechanics, Solid State Physics, Modern Physics, Elementary Particle Physics, Quantum Field Theory, Graduate Standard Model of Elementary Particles. Dr. Alexander has mentored undergraduate, graduate and post-doctoral fellows nationally and internationally.

James Jackson, Ph.D.

Dr. Jackson is the Daniel Katz Distinguished University Professor of Psychology, Professor of Afroamerican and African Studies, and Director of the Institute for Social Research, all at the University of Michigan. His research focuses on issues of racial and ethnic influences on life course development, attitude change, reciprocity, social support, and coping and health among blacks in the Diaspora. He is past Director of the Center for Afroamerican and African Studies and past national president of the Association of Black Psychologists. He is a fellow of the Gerontological Society of America, the Society of Experimental Social Psychology, the American Psychological Association, the Association of Psychological Sciences, AAAS, and the W.E.B. Du Bois Fellow of the American Academy of Political and Social Science. He has received numerous awards, including the Distinguished Career Contributions to Research Award of the Society for the Psychological Study of Ethnic Minority Issues, the James McKeen Cattell Fellow Award for Distinguished Career Contributions in Applied Psychology of the American Psychological Association, and the Medal for Distinguished Contributions in Biomedical Sciences of the New York Academy of Medicine. He is the President of the Consortium of Social Science Associations (COSSA). He is a member of the Institute of Medicine and a fellow of the American Academy of Arts and Sciences.
He is currently directing the most extensive social, political behavior, and mental and physical health surveys on the African American and Black Caribbean populations ever conducted. He serves on several Boards for the National Research Council and the National Academies of Science and is a founding member of the new "Aging Society Research Network" of the MacArthur Foundation.

Appendix B: 2014 Ernest E. Just Symposium Student Attendees

Schools that Participated in the 2014 Ernest E. Just Symposium	
Name of School	**# of Students**
Anderson University	18
Benedict College	24
The Citadel	3
Claflin University	20
Clark Atlanta University	15
Clemson University	10
Coastal Carolina University	7
Fayetteville State University	25
Florida A&M	50
Furman University	10
Morehouse College	15
Savannah State University	6
Spelman	15
South Carolina State University	7
University of Maryland Baltimore County	5
USC Aiken	10
USC Upstate	6
Voorhees College	5
TOTAL	251



Appendix C: 2014 Students Supported from Leveraged Funding Sources

Summer 2014 DOD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program Additional Students, Mentors, Funding Sources, and Research Topics				
Student Name	**Academic Institution**	**MUSC Research Mentor**	**Funding Source**	**Research Topic**
Ms. Bobbie Blake	Claflin University	Victoria Findlay, PhD	National Institutes of Health/ National Cancer Institute	miR-204 mediated negative regulation of Cav1 as a mechanism driving breast cancer disparity
Mr. Jamie Lyons	SC State University	Bartholomeus Smits, PhD	MUSC Hollings Cancer Center	Genetic elements associated with breast cancer susceptibility in women of African American and European Descent

Appendix D: Summaries of Students' Scientific Research from the 2014 Summer Research Program

Casseanna Holmes
Voorhees College
Mentor: David Turner, PhD

ABSTRACT

Targeting RAGE Expression in Breast Cancer

RAGE is associated with breast cancer pathways. RAGE is a transmembrane receptor for Advanced Glycation End products (AGEs). AGEs are proteins or lipids that become non-enzymatically glycated and oxidized. RAGE is a receptor found on the surface of a cell that can be bound by AGEs. This leads to the activation of signal transduction pathways that cause inflammation associated with many diseases including cancer. Inflammation is a sign associated before the onset of cancer and after. RAGE expression is incremented in many tumor types including breast. We examined RAGE in MCF7 cells after using shRNA viruses to knock down dead cells. That will allow us to provide initial evidence that the transmembrane receptor RAGE promotes cancer associated pathways in breast cancer. We reduced the expression of RAGE using lentiviral mediated shRNA in MCF7 breast cancer cell lines. We confirmed the loss of expression of RAGE using Real Time PCR analysis (mRNA) and Western blot (Protein). We used a colorimetric sulforhodamine B (fluorescent dye) growth assay to examine the ability of MCF7 breast cancer cell lines to grow with reduced RAGE expression.

When examined by real time PCR we saw successful reduction of Rage mRNA in the 165,528 and 963 clones, but saw increase mRNA expression in 572 and 878 clones. When examined by the western blot we saw that shRNA virus successfully reduced RAGE protein expression using the 582,528,963 and 878 clones. There was a total knock down of RAGE in the four clones. The data supports that RAGE was successfully knocked down in the MCF7 cells and that RAGE is associated with pathways of breast cancer.

TARGETING RAGE EXPRESSION IN BREAST CANCER

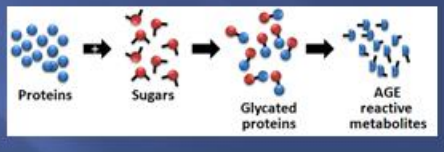
By: Casseanna Holmes
Voorhees College
Mentor: Dr. David Turner

Breast Cancer Background

- Breast Cancer is a disease that develops when unusual cells from the breast tissue grow out of contro1
- Breast Cancer occurs in men and women.
- The risk of developing breast cancer elevates as we get older.
- Screening for breast cancer can preserve lives by detecting breast cancer at its early stage.
- Breast cancer diagnosed at an early stage is more easy to cure.

AGEs

- AGEs are proteins or lipids that become nonenzymatically glycated and oxidized (amalgamated chemically with oxygen) after contact with a monosaccharide sugar.
- They are the results of a chain of chemical reactions which follow an initial glycation reaction.
- AGEs accumulate in our bodies to drive diseases such as diabetes, cardiovascular disease , neurodegenerative diseases and cancer.
- AGEs can also be absorbed through the diet.
- Increased cooking temperatures, through broiling, frying, and increased temperature times lead to an increase in the amount of AGEs in foods and when ingested in our bodies.
- Foods high in protein and fat, such as meat, cheese, and egg yolks are affluent in AGEs.



RAGE

- RAGE is a receptor found on the cell surface that is bound by AGEs.
- This leads to the activation of signal transduction pathways that cause inflammation associated with many diseases.
- Inflammation is a sign associated before the onset of cancer and after .
- RAGE expression is increased in many tumor types including breast.
- RAGE activation is associated with increased development of cancer and poorer outcomes in a wide variety of tumors.
- AGE ligands can interact in an autocrine manner to activate cell signaling pathways.
- RAGE activation occurs in variety of cell types within the tumor microenvironment, including fibroblasts, leukocytes, and vascular cells, leading to increased inflammation.

AGE → RAGE → CELL SIGNALING → CANCER

shRNA

- shRNA is a sequence of RNA that makes a tight hairpin turn that can be habituated to target gene expression through RNA interference.
- Expression of shRNA in cells is typically accomplished through viral or bacterial vectors.

Methods

- We used the immortalized breast cancer cell line MCF7 . Using these cells allowed us to use the same steady cells throughout our research.
- We used shRNA to knock out RAGE using shRNA viruses.
- Stable knockdown of RAGE expression in MCF7 cells was achieved through lentiviral infection using shRNA virus.
- Real Time PCR analysis
- Western Blot analysis
- Cell growth assay

We infected MCF7 cells with lentivirus expressing shRNA constructs which target the expression of RAGE and examined the levels of RAGE mRNA in response.

When examined by real time PCR analysis we saw a successful reduction of RAGE mRNA using three of the 5 shRNA clones examined. shRNA clones 165, 528 and 963 clones all showed a substantial loss of RAGE mRNA expression. Clones 582 and 878 failed to reduce RAGE mRNA levels.

This may be due to the fact that the shRNA bound mRNA was inhibited but not degraded as observed with the other clones.

Figure 1. Reduction of Rage mRNA in MCF7 cells

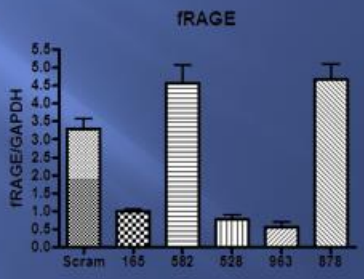


Figure 2. RAGE protein was knocked down in MCF7 cells

We infected MCF7 cells with lentivirus expressing shRNA constructs which target the expression of RAGE and examined the levels of RAGE protein in response.

When examined by western blot we saw that the RAGE shRNA virus successfully reduced the protein expression when using clones 582, 528, 963 and 878 where there was a total knock down of RAGE. For clone 165 we saw an approximate 50% reduction in RAGE protein compared to the scrambled control.

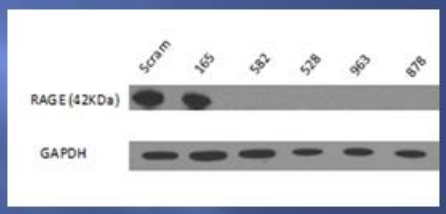
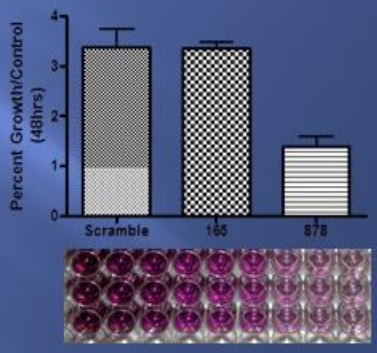
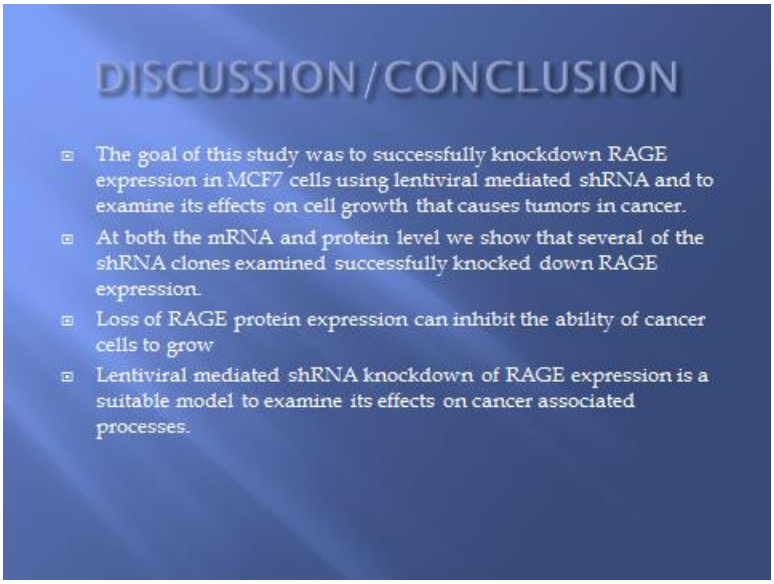


Figure 3. Loss of RAGE expression reduces the ability of MCF7 cells to grow

We examined cancer cell growth in our MCF7 cells with reduced RAGE expression using SRB assays.

When compared to control cells that contain non-trageting shRNA and have normal RAGE expression (scramble), the ability of cancer cells to grow was not inhibited in the 165 RAGE shRNA clone but was significantly inhibited in the 878 clone.




DISCUSSION/CONCLUSION
The goal of this study was to successfully knockdown RAGE expression in MCF7 cells using lentiviral mediated shRNA and to examine its effects on cell growth that causes tumors in cancer.
At both the mRNA and protein level we show that several of the shRNA clones examined successfully knocked down RAGE expression.
Loss of RAGE protein expression can inhibit the ability of cancer cells to grow
Lentiviral mediated shRNA knockdown of RAGE expression is a suitable model to examine its effects on cancer associated processes.

Franshawn Mack
South Carolina State University
Mentor: Marvella E. Ford, PhD

ABSTRACT

Evaluating the Prevalence of Overweight/Obesity and Physical Activity in a Diverse Sample of South Carolina Breast Cancer Survivors

BACKGROUND: High body mass index (BMI) is linked to poorer survival after breast cancer diagnosis. Physical activity (PA) could moderate this association.

OBJECTIVES/HYPOTHESIS: Prevalence of high BMI (overweight/obesity) and level of PA were evaluated in a statewide sample of women within 18 months of breast cancer diagnosis.

METHODS: In an ongoing study, 73 women (35 EA and 38 AA) were identified through the SC Central Cancer Registry, and were interviewed to obtain their self-reported body weight, height, PA and other data.

RESULTS: *Age:* Age ranged from 26 to 90 years (mean 61 years, SD 13.0), with AAs 2.1 years younger than EAs (p=0.49). *Education:* 62% had more than a high school (HS) diploma (58% of AAs and 66% of EAs, p=0.49). *BMI:* 77% were overweight/obese; 42% of AAs and 31% of EAs were overweight, 45% of AAs and 34% of EAs were obese (p=0.03). *PA:* 23% reported no PA (29% of AAs and 17% of EAs, p=0.23). Only 38% met CDC PA guidelines of at least 150 min/week of moderate PA (29% of AAs and 47% of EAs; p=0.11). *PA and BMI:* PA <90 min/week was associated with 4-fold higher risk of overweight/ obesity (p=0.023). No significant associations were seen by race. *PA and Education:* No significant association was observed between >HS education and meeting PA guidelines (p=0.15), or between >HS education and greater PA per week (p=0.57). *Education and BMI:* No significant association was seen (p=0.77).

CONCLUSIONS: Prevalence of overweight/obesity was high, especially among AAs.

FUTURE RECOMMENDATIONS: It is imperative to identify strategies to reduce obesity/overweight in BRCA survivors.

Evaluating Rates of Overweight/Obesity and Physical Activity in a Diverse Sample of South Carolina Breast Cancer Survivors

Franshawn Mack, Rising Junior
South Carolina State University

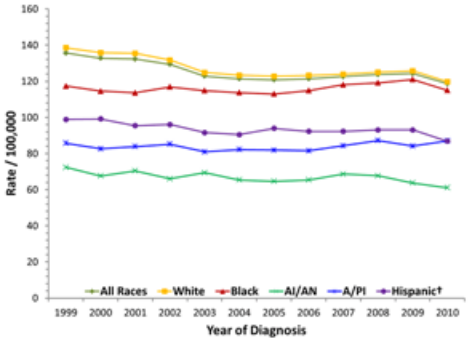
Presentation Outline

- Statement of the Problem
- Breast Cancer Incidence and Mortality Rates in the US and SC
- Obesity Rates in the US and SC
- Project Overview
  - Rationale
  - Methods
  - Results
  - Conclusions
  - Limitations
  - Acknowledgements

Statement of the Problem

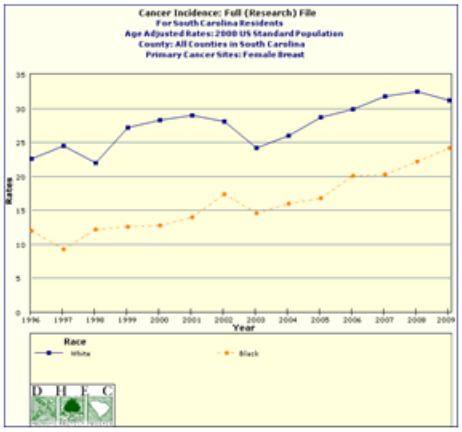
- Women who are overweight or obese have a significantly higher risk of breast cancer recurrence than women with normal weight
- Breast cancer mortality rates are highest among African American women, who also experience the highest rates of obesity

Female Breast Cancer Incidence Rates by Race and Ethnicity U.S., 1999–2010

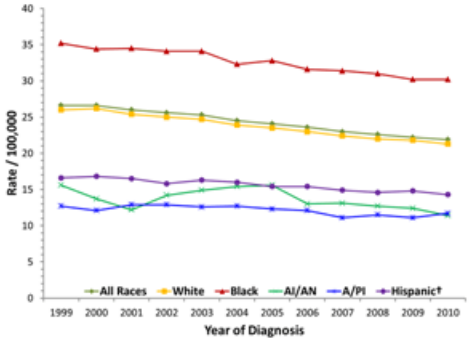


Incidence source: Combined data from the National Program of Cancer Registries as submitted to CDC and from the Surveillance, Epidemiology and End Results program as submitted to the National Cancer Institute in November 2012. http://www.cdc.gov/cancer/breast/statistics/race.htm

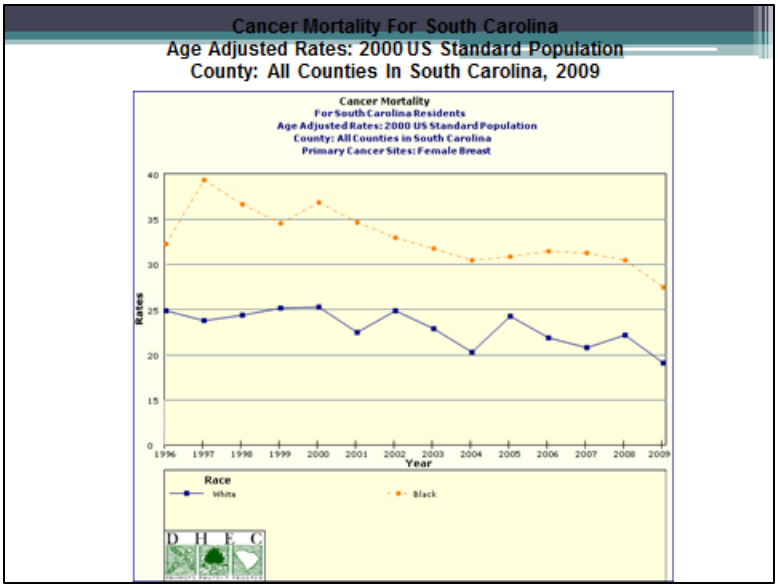
Cancer Incidence For South Carolina Age Adjusted Rates: 2000 US Standard Population County: All Counties In South Carolina, 2009

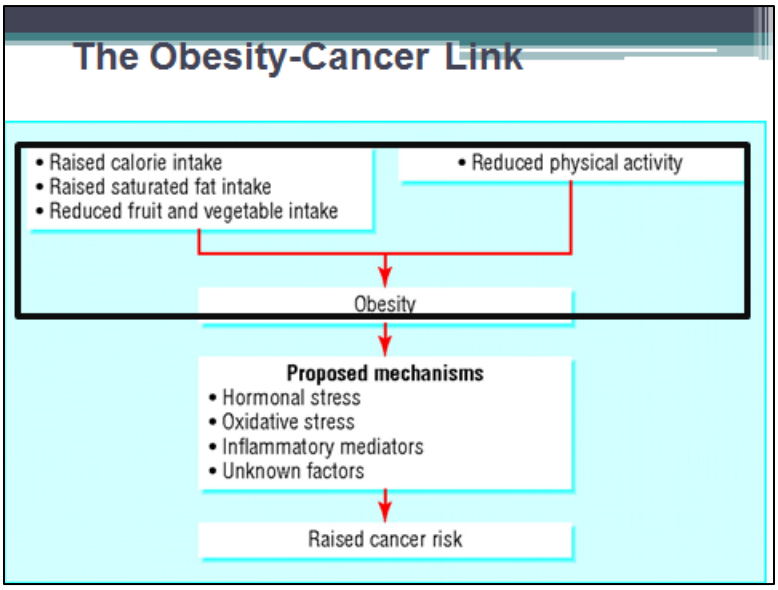


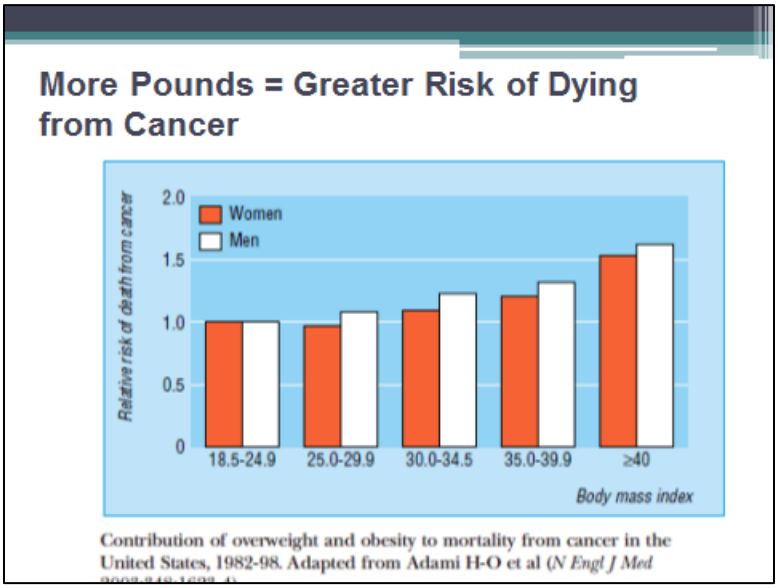
Female Breast Cancer Death Rates by Race and Ethnicity U.S., 1999–2010



Mortality source: U.S. Mortality Files, National Center for Health Statistics, CDC. http://www.cdc.gov/cancer/breast/statistics/race.htm







Contribution of overweight and obesity to mortality from cancer in the United States, 1982-98. Adapted from Adami H-O et al (*N Engl J Med*

What is the Body Mass Index (BMI)?

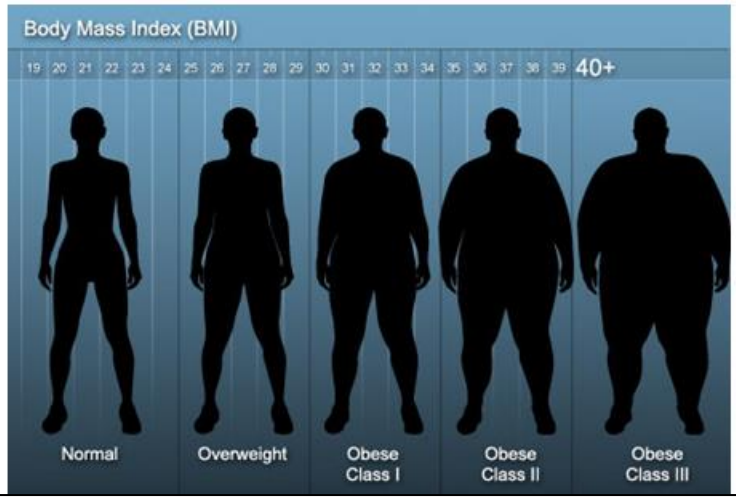
- Normal BMI =18.5-24.9
- Overweight BMI: 25.0-29.9
- Obese BMI= 30-

$$BMI = \frac{\text{weight (lb)} * 703}{\text{height}^2\ (\text{in}^2)}$$

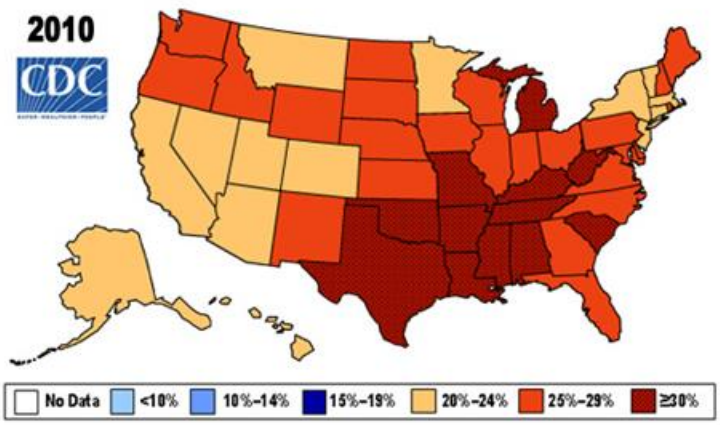
OR

$$BMI = \frac{\text{weight (kg)}}{\text{height}^2\ (\text{m}^2)}$$ (metric)

What is the Body Mass Index (BMI)?



Percent of Obese (BMI > 30) in U.S. Adults



South Carolina Obesity Data

	Neither overweight nor obese (BMI < = 24.9)	OVERWEIGHT (BMI = 25.0 - 29.9)	OBESE (BMI = 30.0 - 99.8)
European American	35.8	35.8	28.3
African American	24.3	34.7	41.0

(BRFSS, 2010)

Project Overview

Rationale

- **Objective**: To describe and compare the distributions of body mass index (BMI) and physical activity (PA) in this multi-ethnic state-wide sample, using data available to date.

Methods

Study Sample

- Adult women, recruited within 18 months of invasive BC diagnosis.
- Cases identified from throughout SC, contacted, and referred to MUSC study staff by the SC Central Cancer Registry.
- Recruited by MUSC study staff, who administer a short interview to obtain self-reported data: race, ethnic ancestry, age, education, height, weight, physical activities, time per physical activity.

Characterizing BMI and PA

- CDC BMI categories (CDC, 2011) and 2008 Physical Activity Guidelines (HHS, 2009).

Results

Demographic and Disease Characteristics

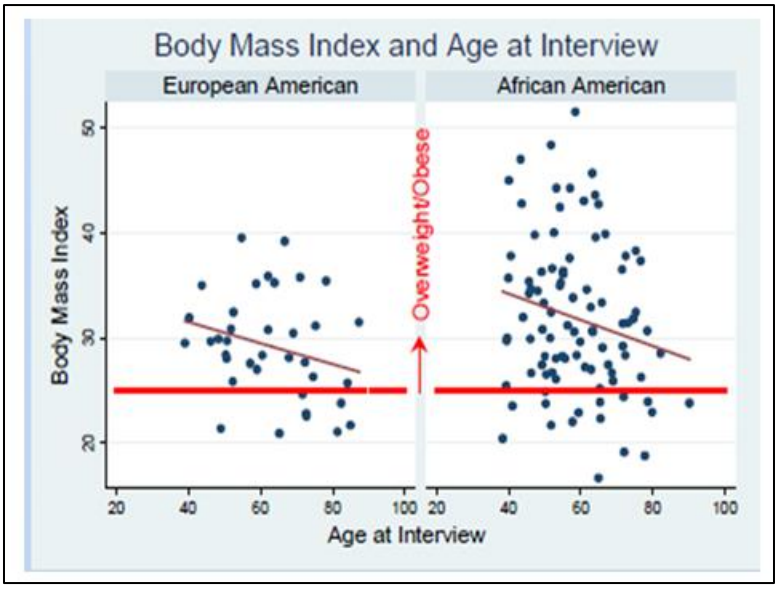
- 130 women were interviewed:
  - 93 are AA and 37 are EA
- Age range: 38 to 90 years (mean 29.9, SD 12.3):
  - AA mean age = 4.3 years younger than EA mean age (p=0.07)
- Education: majority (57%) reported more than a HS diploma:
  - 54% of AAs, and 65% of EAs (p=0.25)

Demographic and Disease Characteristics(cont'd)

- Stage: 37% of women had Regional/Distant disease:
  - 44% of AAs and 19% of EAs (p=0.009)

Overweight/Obesity

- BMI mean was 31.1 (SD 6.8, median 30.2, range 16.6 – 51.6):
  - Higher in AAs: mean 31.8 vs 29.2 in EAs (p=0.019).
- Majority (82%) were overweight/obese (not statistically different by race: p=0.56):
  - 83% of AAs: 29% overweight, 54% obese (31% extremely obese)
  - 78% of EAs: 38% overweight, 41% obese (19% extremely obese)

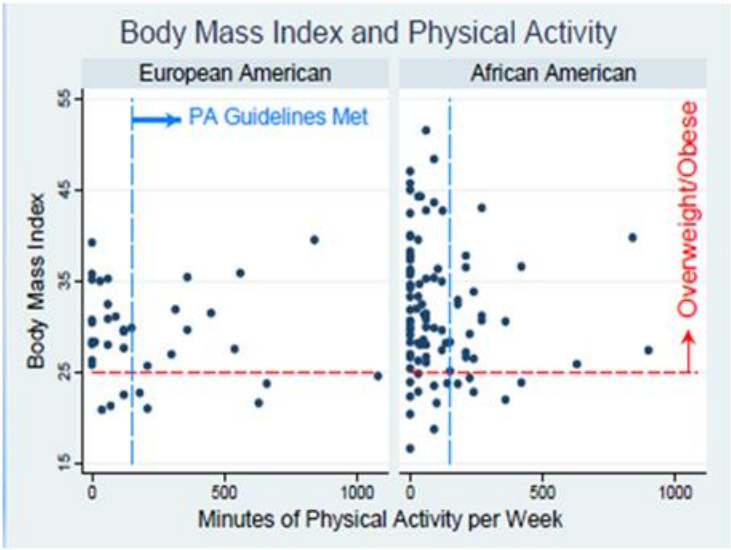


Overweight/Obesity (cont'd)

- Older women were more likely to have lower BMI (-0.13 BMI units/year of age, p=0.008), particularly among AAs (p=0.055).
- No statistical differences found to date between SI and Non-SI AAs.
- No association with stage of breast cancer was seen (p=0.86).

Physical Activity (PA)

- CDC guideline adherence of ≥150 minutes/week of moderate PA was reported by only 30% of participants (26% of AAs, 41% of EAs; p=0.11).
- 31% reported having no PA (34% of AAs, 24% of EAs, p=0.40).
- EAs reported more PA: EA median 120 minutes/week, mean 210; AA median 60 minutes, mean 110 (medians: p=0.051)



Physical Activity (cont'd)

- Trend leaned towards normal weight if CDC guidelines were met (OR=0.49; p=0.13).
- Greater PA is associated with lower BMI (p=0.045) with no trend by race.
- No association with stage of breast cancer were seen (p>0.17).

Conclusions

Conclusions related to Overweight/Obesity

- The prevalence of overweight/obesity was high, regardless of race, but especially among (younger) AAs.
- The prevalence of overweight/obesity was somewhat greater in this sample of recent BC survivors than in SC general female adult population for AAs (83% vs 75% in SC) and for EAs (78% vs 65% in SC) according to BRFSS data for 2011.
- Overweight/obesity showed no association with stage of invasive BC.

Conclusions related to Physical Activity (PA)

- Low PA rates were seen in this group of breast cancer survivors.
- Little correlation between PA and BMI was found.
- It is imperative to identify strategies to reduce overweight and obesity, to reduce the risk of breast cancer recurrence and improve survival rates.

Limitations

- Sample was only drawn from SC
- Data were pulled from SC cancer registry
- BMI measures were compiled based on measurements listed for each patient in the registry

Acknowledgements

- US Department of Defense (DOD) SE VIEW grants
  - W81XWH-11-2-0164
  - W81XWH-10-2-0057
- DOD CDMRP grant
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  - 5P20CA157071-02
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- Marvella E. Ford, PhD
- Kendrea Knight, MSPH
- Heidi Varner
- Tonya Hazelton

Jagreet Singh
Claflin University
Mentor: Shikhar Mehrotra, PhD

ABSTRACT

Antioxidant Capacity of MDSCs: Potential Target For Immunotherapy

Myeloid-derived suppressor cells (MDSCs) are present in most cancer patients and are potent inhibitors of T-cell-mediated anti-tumor immunity. Their inhibitory activity is attributed to production of an array of immunosuppressive cytokines and reactive oxygen species (ROS). Given that ROS are highly detrimental and can induce apoptosis to variety of cells including T cells, it is still obscure how MDSCs resist the oxidative stress mediated death in oxidative tumor microenvironment. To gain insight into the mechanism of how MDSCs withstand oxidative insult, MDSCs were generated from bone marrow cells and characterized them using flow cytometry. The expression of various genes associated with anti-oxidant potential of the cells was evaluated in MDSCs using real time PCR. The data suggest that bone marrow cells differentiated to MDSCs mimic the characteristic of tumor derived MDSCs and suppress the proliferation of T cells in vitro suppression assay. We also observed that MDSCs have very high surface expression of glutamate-cystine transporter (xCT) which has been shown to transport cysteine inside the cells and thus maintain high intracellular glutathione (GSH) level, an important anti-oxidant of the cells. Our study indicate that selective apoptosis can be induced in MDSCs by inhibiting xCT which in turn deplete GSH level by limiting the availability of cysteine. Thus the present study opens up a new avenue of overcoming tumor microenvironment induced suppression of anti-tumor T cells response by targeting MDSCs by targeting its anti-oxidant status.

Antioxidant Capacity Of MDSCs : Potential Target For Immunotherapy

JAGREET SINGH

Dr. Shikhar Mehrotra

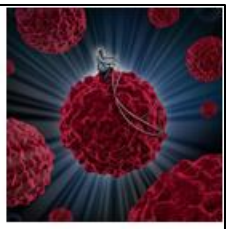
What are MDSCs ?

- Myeloid derived suppressor cells (MDSCs), a heterogeneous population of immature monocytes, macrophages, neutrophils and DCs, accumulate in the blood, bone marrow, spleen. *(Gabrilovich DI and Nagraj S. Nat Rev Immunol. 2009).*
- They are present in most cancer patients and are potent inhibitors of T-cell-mediated anti-tumor immunity. *(Gabrilovich DI and Nagraj S. Nat Rev Immunol. 2009).*
- MDSCs negatively regulate the immune responses by inhibiting T-cells responses and supports tumour growth and metastasis. *(Cui Tx et al. Immunity. 2013)*
- In mouse MDSC cells express high levels of surface markers of CD11b and GR1.

Hypothesis

- Since studies have shown that MDSCs can survive in highly oxidative tumor microenvironment where a normal cell cannot, so we hypothesized that they possess high anti-oxidant capacity to withstand high oxidative stress.

OBJECTIVES



- 1: To find the levels of Glutathione (GSH) in MDSCs cells?
- 2: If they have high level of GSH, why is that ?
- 3: Are they Resistant to Oxidative Cell Mediated Death or not ?

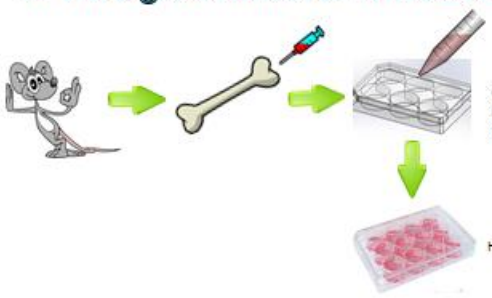
In vitro generation of MDSCs Cells

- Studies have shown that addition of specific Cytokines (GMCSF and IL6) to the bone marrow cells results in the generation of MDSCs cells. *(Marigo I et al. Immunity. 2010).*

- 1 SAMPLE: Bone Marrow (GMCSF)
- 2 SAMPLE: Bone Marrow (GMCSF + IL 6)

} MDSCs Cells

In vitro generation of MDSCs Cells Cont.



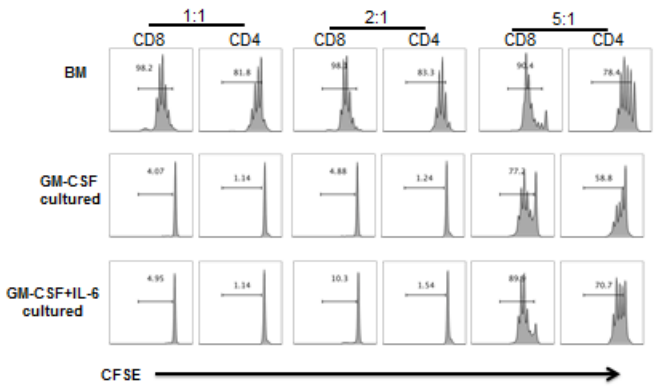
Day = 0

Cells number: 5×10^6 cells/well
Media: complete IMDM; 4ml/well
Cytokine: GM-CFS- 50ng/ml
IL-6- 50ng/ml

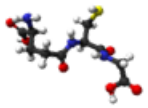
Day = 4

Harvest the cells and analyze

MDSC (in vitro generated) mediated suppression of T cell proliferation



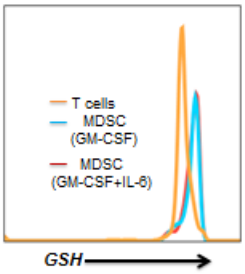
GLUTATHIONE



- **Glutathione (GSH)** is an important antioxidant which prevents damage to important cellular components caused by reactive oxygen species such as free radicals and peroxides
- So we proposed that higher GSH level in MDSCs cells could protect them from oxidative stress mediated death.

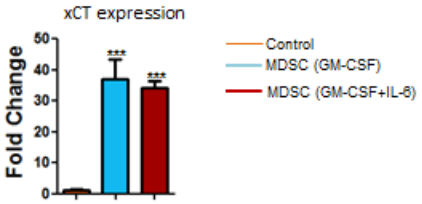
To find the levels of GSH in MDSC cells?

- MCB(Monochlorobimane) staining.



If They Have High Level, Why Is So?

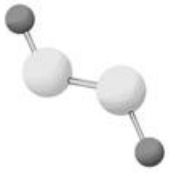
- xCT is the main transporter of cystine.
- Cystine is the main component of Gsh. **(Cysteine, Glutamic acid and Glycine)**
- High level of xCT ⟶ High level of Gsh.
- So, we checked the xCT expression of MDSCs cells by q-PCR.

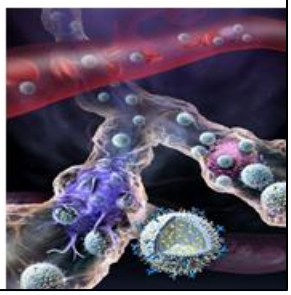


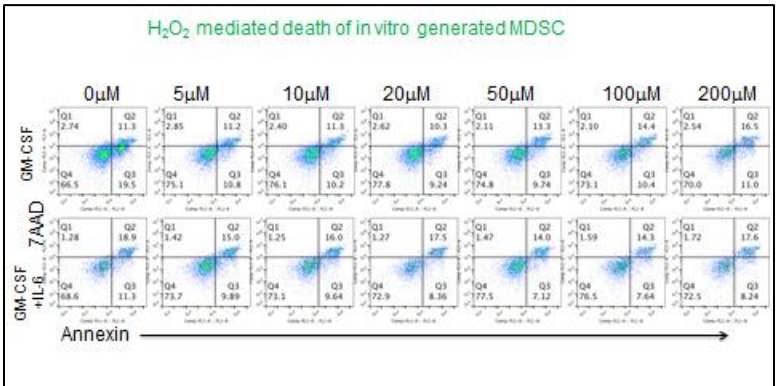
MDSCs Cells are Resistant To Oxidative Cell Mediated Death Or Not?

- Annexin staining (Stained with Annexin and 7AAD)
- Added different concentration of H_2O_2.

- H_2O_2 conc: OuM.
  5uM.
  10uM.
  25uM.
  50uM.
  100uM.
  200uM.







"Yes" They are resistant to Oxidative Cell Mediated Death.

Potential Target For Immunotherapy

- MDSCs – Major hindrance for successful application of T-cells immunotherapy in cancer.
- **Overcoming**: Depletion of xCT transporter.

CONCLUSION

- Targeting Antioxidant capacity of MDSCs cells by inhibiting xCT transporter could ameliorate the efficacy of T-cell Immunotherapy of cancer.

Acknowledgement

- **Dr. Marvella E. Ford**
- **Dr. Shikhar Mehrotra**
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- **Dr. Krishnamurthy Thyagarajan**
- **Myra Soloshchenko**
- **MUSC**
- **Claflin University**

Khaalida Poindexter
South Carolina State University
Mentor: Victoria J. Findlay, PhD

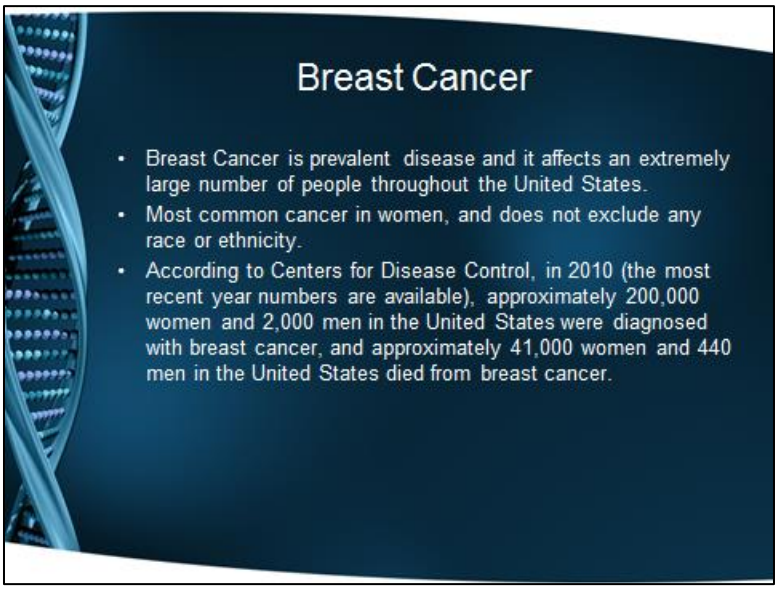
ABSTRACT

miRNA-510 as a Non-Invasive Biomarker in Triple Negative Breast Cancer

Breast cancer is a very diverse disease that can be classified into different subtypes based on the expression of estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2). These receptors are not present in a subtype known as triple negative breast cancer (TNBC), making it resistant to targeted therapies against these receptors; therefore cytotoxic chemotherapy remains the standard of care for these patients. Cisplatin is a chemotherapeutic agent that is being investigated for treating TNBC patients, however not all patients respond to cisplatin. Therefore it is important to identify potential biomarkers to differentiate sensitive patients to help improve treatment outcome for this aggressive subtype of breast cancer. MicroRNAs (miRNA) are small, non-coding RNA involved in post-transcriptional gene regulation and dysregulation of miRNAs has been shown to be involved in cancer. Drug cytotoxicity data have shown that miR-510 overexpression increases sensitivity to cisplatin in in vitro breast cancer cell lines, as well as in vivo. MicroRNAs can be detected in many biological fluids, including serum samples; therefore miR-510 may be a potential non-invasive biomarker to help predict response to the cisplatin in TNBC patients. Quantitative PCR analysis of mouse serum and tumor RNA showed that serum expression of miR-510 positively correlates with its matched tumor expression and may be a potential, non-invasive biomarker of cisplatin sensitivity in TNBC.


miRNA-510 as a Non-Invasive Biomarker in Triple Negative Breast Cancer
Khaalida Poindexter
South Carolina State University


Overview
• Breast Cancer
• Triple Negative Breast Cancer
• MicroRNAs
• Biomarkers
• Materials & Methods
• Results
• Discussion


Breast Cancer
• Breast Cancer is prevalent disease and it affects an extremely large number of people throughout the United States.
• Most common cancer in women, and does not exclude any race or ethnicity.
• According to Centers for Disease Control, in 2010 (the most recent year numbers are available), approximately 200,000 women and 2,000 men in the United States were diagnosed with breast cancer, and approximately 41,000 women and 440 men in the United States died from breast cancer.

Triple Negative Breast Cancer

- Triple Negative Breast Cancer (TNBC), is phenotypically characterized by a lack of expression of estrogen receptor (ER), progesterone (PR) and the absence of human epidermal growth factor receptor (HER2) over expression and/or amplification.
- Has the poorest prognosis
- More aggressive than other types of breast cancer
- No current targeted therapies
- Chemotherapy is the mainstay treatment

Triple Negative Breast Cancer (cont.)

- Current research is focused on finding targeted therapies for TNBC which includes platinum agents such as cisplatin.
- Cisplatin is a widely used anti-cancer drug that damages DNA.
- This inhibits DNA replication and then leads to cell death in cancer cells.
- A clinical trial found that not all patients respond well. Therefore biomarkers are needed to help differentiate patients who respond to cisplatin and the patients who do not.

MicroRNAs

- MicroRNAs are a class of post-transcriptional regulators.
- The dysregulation of microRNA expression has been showed to be involved in cancer.
- The purpose of this study is to have cancer patients respond well to the non-invasive biomarker.
- Treating only patients who are responsive to the biomarker is more effective than treating those who are not.

Biomarkers

- A biomarker is a measurable indicator which can help to predict the response of the cisplatin drug.
- Cisplatin is a cytotoxic drug used in cancer chemotherapy.

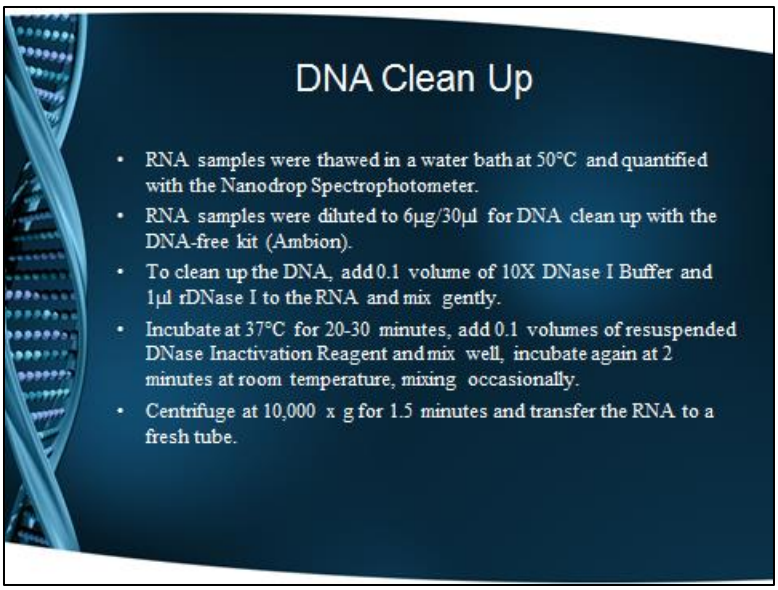
Materials & Methods

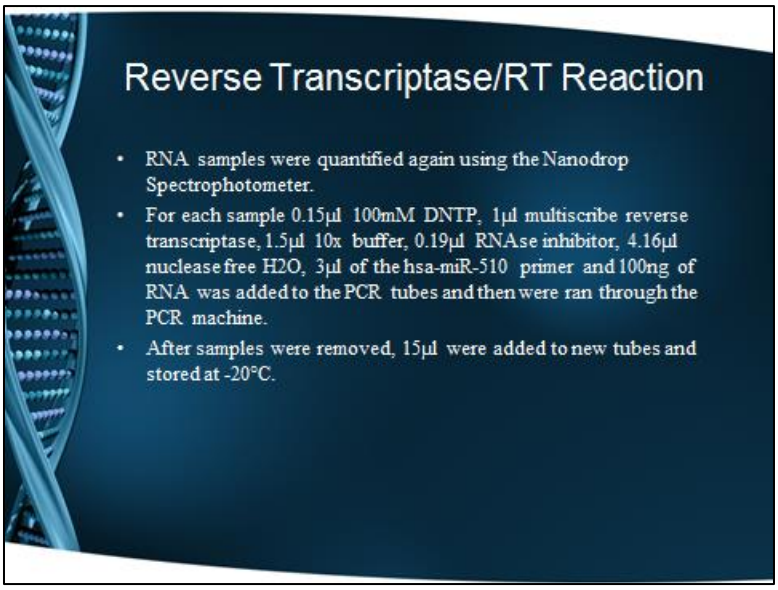
- Steps taken for this research project were:

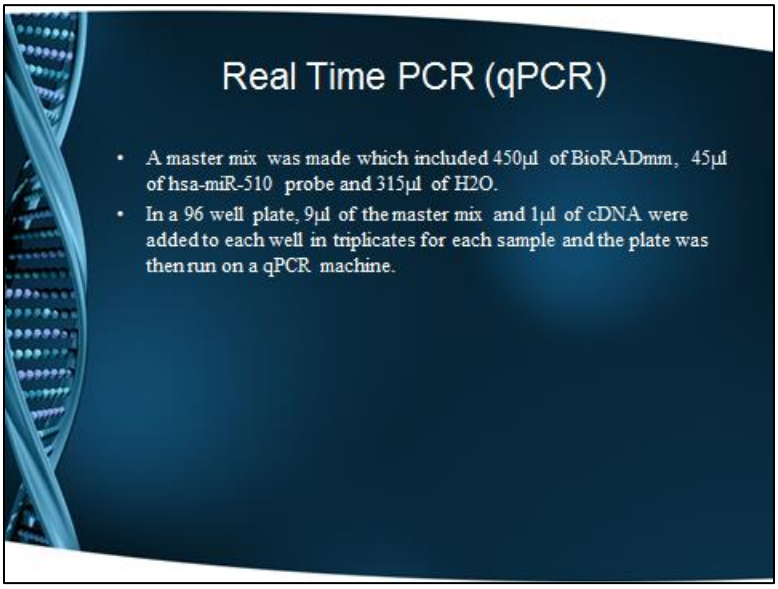
1. RNA Extraction
2. DNA Clean Up
3. Reverse Transcriptase/RT Reaction
4. Real Time PCR (qPCR)

RNA Extraction

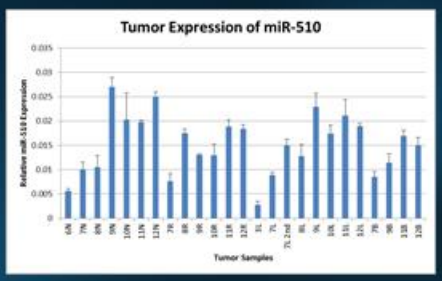
1. Thawed tumor samples from -80°C, added them to a chilled mortar with liquid nitrogen, and crushed it until it became a fine powder.
2. Transferred it to 2mL microcentrifuge tube. Samples were then stored at -80°C until RNA extraction was performed.
3. Samples were incubated at room temperature in vortex and then centrifuged.


DNA Clean Up
• RNA samples were thawed in a water bath at 50°C and quantified with the Nanodrop Spectrophotometer.
• RNA samples were diluted to 6µg/30µl for DNA clean up with the DNA-free kit (Ambion).
• To clean up the DNA, add 0.1 volume of 10X DNase I Buffer and 1µl rDNase I to the RNA and mix gently.
• Incubate at 37°C for 20-30 minutes, add 0.1 volumes of resuspended DNase Inactivation Reagent and mix well, incubate again at 2 minutes at room temperature, mixing occasionally.
• Centrifuge at 10,000 x g for 1.5 minutes and transfer the RNA to a fresh tube.


Reverse Transcriptase/RT Reaction
• RNA samples were quantified again using the Nanodrop Spectrophotometer.
• For each sample 0.15µl 100mM DNTP, 1µl multiscribe reverse transcriptase, 1.5µl 10x buffer, 0.19µl RNAse inhibitor, 4.16µl nuclease free H2O, 3µl of the hsa-miR-510 primer and 100ng of RNA was added to the PCR tubes and then were ran through the PCR machine.
• After samples were removed, 15µl were added to new tubes and stored at -20°C.

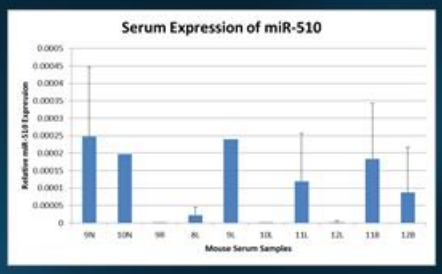

Real Time PCR (qPCR)
• A master mix was made which included 450µl of BioRADmm, 45µl of hsa-miR-510 probe and 315µl of H2O.
• In a 96 well plate, 9µl of the master mix and 1µl of cDNA were added to each well in triplicates for each sample and the plate was then run on a qPCR machine.

Tumor Expressions of miR-510



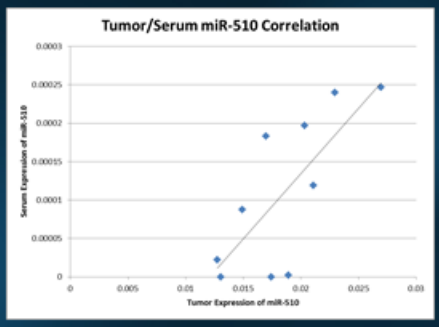
In figure 1, the 510 levels 6N and 3L are very low which is expected since those levels of 510 are scrambled. All of the other samples are expected to be high since they are not scrambled.

Serum Expression of miR-510



In figure 2, it shows that more than half of the samples were inaccurate based off of how far the lines were stretched over the bars.

Tumor/Serum miR-510 Correlation



In figure 3, a scatter plot shows the tumor expression miR-510 plotted with matched serum expression miR-510. A linear trend line was added to see the correlation.

Discussion

- In assessing miR-510 expression in tumor samples in Figure 1 shows that miR-510 expression is low in SCR tumors. While the 510 tumors showed varying levels of miR-510 expression, the expression is higher than SCR tumors as expected. Figure 2 shows previous work in the lab that analyzed the expression of miR-510 in serum of these experimental mice that were available.
- For samples with matched tumor and serum data, tumor expression of miR-510 was plotted against its matched serum expression (Figure 3). The linear trend line revealed a Pearson's Correlation coefficient to be r=0.74, indicating a strong positive correlation of tumor and serum expression of miR-510. This suggests that tumors with high miR-510 expression will also exhibit high serum levels of miR-510 and vice versa. Future direction will be to investigate this correlation in human breast cancer samples. This will further help determine if miR-510 is a suitable non-invasive, biomarker for cisplatin sensitivity and help improve prognosis in TNBC.

Acknowledgements

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- Dr. Marvella Ford
- Dr. Victoria Findlay
- Qi Guo
- MUSC

Appendix E: Academic Accomplishments to Date of the 2014 Student Fellows

Year of Program Participation: 2014 ❖ These are the most recent student fellows that participated in the 2014 SURP program. Additional accomplishments are expected to occur during the course of the next few years following their participation.					
Student Name	**Summer Research Project**	**Funding Source**	**Publications and Presentations**	**GRE Status**	**Graduate School Admission**
Ms. Casseanna Holmes Voorhees College	**Mentor:** David P. Turner, PhD **Research Project:** Targeting RAGE Expression in Breast Cancer	Department of Defense (HBCU)	**Publication:** No publications to date **Presentation:** 2014 MUSC Summer Undergraduate Research Program	Has taken the GRE	Still enrolled at Voorhees College
Ms. Franshawn Mack (Dual Year Participant 2013/2014) SC State University	**Mentor:** Marvella E. Ford, PhD **Research Project:** Evaluating the Prevalence of Overweight/Obesity and Physical Activity in a Diverse Sample of South Carolina Breast Cancer Survivors	Department of Defense (HBCU)	**Publication:** No publications to date **Presentation:** 2014 MUSC Summer Undergraduate Research Program Southeast Regional Research Conference in Little Rock, Arkansas on November 15-17, 2013 (oral presentation)	Expected to take the GRE in Fall 2015	Expected to graduate May 2016
Ms. Khaalida Poindexter SC State University	**Mentor:** Victoria Findlay, PhD **Research Project**: miRNA-510 as a Non-Invasive Biomarker in Triple Negative Breast Cancer	Department of Defense (HBCU)	**Publication:** No publications to date **Presentation:** 2014 MUSC Summer Undergraduate Research Program	Has not taken the GRE	Still enrolled at SC State University
Mr. Jagreet Singh Claflin University	**Mentor:** Shikhar Mehrotra, PhD **Research Project:** Antioxidant Capacity Of MDSCs: Potential Target For Immunotherapy	Department of Defense (HBCU)	**Publication:** No publications to date **Presentation:** 2014 MUSC Summer Undergraduate Research Program	Expected to take DAT in 2015	Expected to graduate May 2015, Biology
Students Supported by Leveraged Funding Sources					
Student Name	**Summer Research Project**	**Funding Source**	**Publications, Presentations and Honors**	**GRE Status**	**Graduate School Admission**
Ms. Bobbie Blake (Dual Year Participant 2013/2014) Claflin University	**Mentor:** Victoria Findlay, PhD **Research Project:** miR-204 mediated negative regulation of Cav1 as a mechanism driving breast cancer disparity	National Institutes of Health/ National Cancer Institute	**Publication:** No publications to date **Presentation:** 2014 MUSC Summer Undergraduate Research Program	Took the GRE in the Fall of 2013	Accepted into the Master's in Biotechnology Program at Claflin University
Mr. Jamie Lyons SC State University	**Mentor:** Bartholomeus Smits, PhD **Research Project:** Genetic elements associated with breast cancer susceptibility in women of African American and European Descent	MUSC Hollings Cancer Center	**Publication:** No publications to date **Presentation:** 2014 MUSC Summer Undergraduate Research Program	Expected to take the GRE	Graduated from SC State University May 2015

Appendix F: Publication Describing the Scope and Outcomes of the Training Program

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Mentoring Strategies and Outcomes of Two Federally Funded Cancer Research Training Programs for Underrepresented Students in the Biomedical Sciences

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Abstract The US is experiencing a severe shortage of underrepresented biomedical researchers. The purpose of this paper is to present two case examples of cancer research mentoring programs for underrepresented biomedical sciences students. The first case example is a National Institutes of Health/National Cancer Institute (NIH/NCI) P20 grant titled "South Carolina Cancer Disparities Research Center (SC CaDRe)" Training Program, contributing to an increase in the number of underrepresented students applying to graduate school by employing a triple-level mentoring strategy. Since 2011, three undergraduate and four graduate students have participated in the P20 SC CaDRe program. One graduate student published a peer-reviewed scientific paper. Two graduate students (50 %) have completed their master's degrees, and the other two graduate students will receive their degrees in spring 2015. Two undergraduate students (67 %) are enrolled in graduate or professional school (grad./prof. school), and the other graduate student is completing her final year of college. The second case example is a prostate cancer-focused Department of Defense grant titled "The SC Collaborative Undergraduate HBCU Student Summer Training Program," providing 24 students training since 2009. Additionally, 47 students made scientific presentations, and two students have published peer-reviewed scientific papers. All 24 students took a

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GRE test preparation course; 15 (63 %) have applied to graduate school, and 11 of them (73 %) are enrolled in grad./prof. school. Thirteen remaining students (54 %) are applying to grad./prof. school. Leveraged funding provided research-training opportunities to an additional 201 National Conference on Health Disparities Student Forum participants and to 937 Ernest E. Just Research Symposium participants at the Medical University of South Carolina.

Keywords Triple-level mentoring strategy · Mentoring programs · Outcomes · Diversity · Underrepresented minority students · Biomedical sciences · Cancer research training programs · Education

Introduction

The US is currently experiencing a shortage of biomedical research scientists. This shortage is experienced most dramatically among diverse populations, where young adults are not entering science, technology, engineering, and mathematics (STEM) careers at significant rates. Diversity in this case refers to young adults who are racially and ethnically diverse, from rural areas, and from low socioeconomic-position backgrounds [1]. Since 2000, the percentage of underrepresented minorities receiving degrees in engineering and the physical sciences has been flat, and participation in mathematics has dropped [1, 2].

Compounding these problems, the demand for cancer prevention, screening, and treatment services will grow over the next two decades as the proportion of older adults in the USA increases, leading to an anticipated 45 % rise in the number of new cancer cases by 2030 [2]. To improve outcomes from the growing cancer problem, investigators must understand the science behind the disease.

Given the potential for dramatic workforce shortages due to the reasons mentioned above, it is imperative to leverage strategies to enhance the scope and diversity of the next generation of cancer researchers and physician scientists. As noted by the Institute of Medicine [3], greater diversity among medical researchers and physicians leads to improved access to care among racially and ethnically diverse patients, greater patient choice and satisfaction, improved patient-provider communication, and better educational experiences for biomedical students during their training [4–6].

A landmark review [7] noted that African Americans are 10 % less likely than European Americans to receive NIH R01 funding, a marker of independent investigator status, even after controlling for demographic characteristics, education and training, and research productivity, among other measures. Increasing the number of diverse investigators who are well-trained in the traditional methodological and analytic principles of research is a critical step toward successfully increasing capacity in cancer health equity research.

The purpose of this paper is to present two case examples of undergraduate student mentoring programs. The case examples are drawn from two federally funded cancer research training grants for underrepresented populations in the biomedical sciences. The first case example is a National Institutes of Health/National Cancer Institute (NIH/NCI) P20 grant titled "South Carolina Cancer Disparities Research Center (SC CaDRe)." The second case example is a prostate cancer-focused Department of Defense grant titled "The South Carolina Collaborative Undergraduate HBCU Student Summer Training Program." The Student Fellows in the NIH/NCI P20 SC CaDRe and the DoD-funded summer research programs are all students who have racial/ethnic backgrounds that are underrepresented in biomedical and biobehavioral research. The design and outcomes of each program will be highlighted. The unintended consequence of leveraging funds through the programs will also be described.

Methods

Case Example 1. NIH/NCI P20 SC CaDRe Grant

Purpose The South Carolina Cancer Disparities Research Center (SC CaDRe) is a formal collaboration between the Medical University of South Carolina (MUSC) and South Carolina State University (SCSU). The primary goal of SC CaDRe is to create a critical mass of well-trained faculty researchers between the two institutions who conduct disparity-focused feasibility studies and obtain preliminary data that leads to further extramural funding. A secondary goal of SC CaDRe is to enhance the racial and ethnic diversity of emerging scientists at all levels. The Student Fellows' summer undergraduate research training program is part of the larger scope of activities that are conducted under the auspices of the NIH/NCI P20 SC CaDRe.

Recruitment Pool Undergraduate students at a local historically black university (Student Fellows) are given financial support to participate in SC CaDRe. Minority status is not an eligibility criteria to become a SC CaDRe-supported Faculty and Student Fellow, but the SC CaDRe leadership give priority to minority applicants, based on the following input from the NIH Slavkin Report: [8]

> "While it is clear that a researcher need not come from a minority or disadvantaged background to contribute to the understanding and remediation of health disparities, it is reasonable to expect that such individuals as a group would possess greater motivation, persistence, familiarity, sensitivity, and insight into this problem. Therefore,

effective recruiting efforts should tap into this talent pool and focus on bringing underrepresented groups into biomedical research."

Recruitment Strategies At the beginning of each spring semester, the investigators identify a pool of potential undergraduates at the advanced undergraduate level (sophomores who have taken advanced science classes, juniors, and seniors). Potential Student Fellows are required to have at least a 3.0 grade point average (GPA). The investigators interview prospective students and select the top candidates based on the interviews, transcripts, letters from the students' academic advisors, and the candidates' interest or desire to conduct prostate or breast cancer research. Based on this process, two Student Fellows are selected per year. Upon acceptance into the P20 SC CaDRe, the Student Fellows are also accepted into a broader summer undergraduate research training program which is integrated with a SC CaDRe-specific training curriculum in prostate and breast cancer research.

Mentoring Strategy Protected one-on-one time with a research mentor is a crucial aspect to research career growth and development. To identify potential mentors, the graduate faculty database is reviewed. All potential mentors are sent an e-mail message to publicize the opportunity to become a research mentor. The SC CaDRe's Student Fellows conduct mentored pilot research. Each mentoring team includes a senior cancer researcher from MUSC (individuals with existing NIH or other federal funding in breast and prostate cancer research), a junior faculty member from SCSU, a junior faculty member from MUSC (junior investigators with no NIH funding), graduate students from MUSC, and Student Fellows from SCSU. To optimize the research mentoring strategy, the SC CaDRe employs a *triple-level mentoring strategy* (as shown in Fig. 1) in which the senior cancer researchers mentor junior faculty, junior faculty mentor graduate students, and graduate students mentor the Student Fellows.To accomplish the goals of the SC CaDRe, the Center adopts/adapts a number of existing interactive research training efforts at both MUSC Hollings Cancer Center (HCC) and SCSU as well as developing new initiatives. All SC CaDRe-supported Student Fellows participated in these year-round activities. The SC CaDRe-supported Student Fellows each begin participating in the summer as part of the summer undergraduate research program and then continue through the fall and spring semesters by participating in the following activities:

- SC CaDRe Visiting Scholars—nationally renowned cancer disparities researchers spend a day at MUSC to give presentations and meet with Student Fellows.
- HCC Annual Spring Research Symposium—thematic research conferences are presented such as "Cancer Disparities: Scope of the Problem and Steps Toward the Solutions," and participants come from around the state, including SCSU.
- HCC Annual Research Retreat—each fall, the HCC hosts a center-wide research retreat where Student Fellows have showcased their research via poster presentations
- Perry V. Halushka Student Research Day—the Perry V. Halushka MUSC Student Research Day is held annually. The SC CaDRe Student Fellows participated in this event, many as oral presenters, an honor that is typically given to graduate students.
- Training in the Responsible Conduct of Research—Student Fellows were required to complete the MUSC Collaborative Institutional Review Board (IRB) Training Initiative (CITI) online program in the responsible conduct of science and ethics and a 4-day Biomedical Ethics class that meets for 2 h per day during the summer.

Case Example 2. Department of Defense-funded South Carolina Collaborative Undergraduate HBCU Student Summer Training Program

Purpose The Medical University of South Carolina (MUSC) and three historically black colleges/universities (HBCUs)—Claflin University (CU), SCSU, and Voorhees College (VC)—are continuing to collaborate under the larger auspices of the South Carolina Cancer Health Equity Consortium (SC CHEC) on the Department of Defense Collaborative Undergraduate HBCU Student Summer Training Program in prostate cancer research. Since the grant's inception, 24 students ("Student Fellows," 4 each summer) have participated in a 10-week program of laboratory rotations and weekly research discussions. The Student Fellows also participate in a twice-weekly, 1-h Prostate Cancer Health Equity Research Course. The course lectures span the spectrum from basic science to clinical science to population sciences. The course includes an

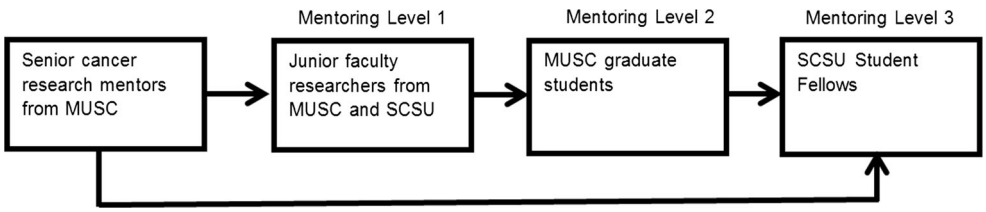

Fig. 1 P20 SC CaDRe Triple-Level Research Mentoring Strategy

introduction to the Sea Island/Gullah population of South Carolina, which is a culturally distinct group of blacks, and one of the most genetically homogeneous in the USA. To date, the Student Fellows have given 47 scientific presentations, and two Student Fellows have written peer-reviewed publications, based on their summer research projects. The ultimate goal of the Training Program is to increase the diversity of emerging scientists who may choose prostate cancer research careers in the basic, clinical, and population sciences.

Recruitment Pool At the beginning of each spring semester, the Training Program Director and Associate Program Directors along with the HBCU Faculty Advisors identify a pool of potential Student Fellows at the advanced undergraduate level (sophomores who have taken advanced science classes, juniors, and seniors). During the past 5 years, the four collaborating institutions have worked closely to advertise inter-institutional research training opportunities. Student Fellows are recruited from the large population of enrolled students at CU, SCSU, and VC. The demographic characteristics of students from each institution for the 2013–2014 academic year who are enrolled in biomedical programs in science, technology, engineering, and mathematics (STEM programs) in each of the three collaborating HBCUs are listed in Table 1, which show the depth of the pool from which the Student Fellows are recruited. Only students who have completed their sophomore or junior year of college are eligible to participate in the Training Program.

Selection of Student Fellows Eligibility criteria for the training program include the following: (1) a written statement of career goals related to biomedical research and interest in cancer research; (2) greater than or equal to a 3.0 GPA based on their official transcripts; and (3) two letters of recommendation from faculty at students' home institutions with at least one from a science course instructor. The program leaders evaluate each applicant, based on these review criteria to determine the top candidates. A scoring algorithm is used so that candidates can be ranked objectively. If an additional level of review is required, they conduct interviews to make the final selections. Priority is given to applicants with backgrounds that are underrepresented in the biomedical sciences. The denominator typically includes approximately 15-20 students. Based on this process, four Student Fellows are chosen each year (ideally, at least one per institution).

Recruitment Strategies During the past 5 years, the four institutions have worked closely to advertise inter-institutional training opportunities, and there are standing protocols in place for advertising summer training opportunities at MUSC through list services, campus newspapers, class announcements, and available packets for each of the faculty advisors to distribute to promising candidates. As an additional recruitment strategy, former Student Fellows are asked to serve as a referral source for interested students, participate in the interview process, and become informal mentors for incoming Student Fellows.

Research Projects and Didactic Training In the Prostate Cancer Health Equity Research Course, each Student Fellow engages in a short-term laboratory prostate cancer research project. This activity is based on the philosophy that a meaningful engagement, involving hands-on applied experiences in a laboratory or research setting with an accomplished cancer researcher will be the most critical catalyst in igniting students' commitment to a biomedical science career.Student Fellows spend up to 35 h per week, earning 15 credits toward graduation, in the laboratory or research offices of an MUSC-based Research Mentor. Guided by the interests expressed by students in their applications, the Leadership Group matches each selected Student Fellow with an appropriate Research Mentor. The Research Mentors shape the Student Fellows' summer experiences to ensure tangible outcomes—presentation of data results (preliminary or final) and submission of scientific abstracts and papers for peer review. Student Fellows are involved in laboratory techniques, data collection and analytic methods, interviewing techniques, data interpretation, and summarizations of results.

Four Student Fellows per year participate in an enriched 10-week summer course that includes an introduction to cancer disparities research, journal clubs, and take-home tests. The Training Program has also been broadened to encompass additional exposure to biomarker development, genetics, survivorship issues, and developmental therapeutics through

Table 1 Demographic characteristics of Biomedical Sciences STEM students in the three collaborating HBCUs

Institution	No. of undergraduates	No. of undergraduates declaring STEM majors	Demographic characteristics of STEM students in the 2013–2014 academic year					
			Gender		Race/ethnicity			
			Male	Female	AA	Hisp./Latino	EA	Other
CU	1886	396	37 %	63 %	96 %	1 %	2 %	1 %
SCSU	3195	909	53 %	47 %	91 %	2 %	5 %	2 %
VC	533	38	44 %	56 %	100 %	0 %	0 %	0 %

shadowing experiences in the MUSC Hollings Cancer Center's (HCC's) clinics, shared resources/cores, and greater interaction with the Sea Island/Gullah population of South Carolina.

Mentoring Program MUSC faculty Research Mentors each commit to providing summer laboratory research training (up to 35 h/week) for 1–2 students each summer in this enhanced comprehensive prostate cancer research training program. This mentoring pool is continuously deepening with ongoing faculty recruitment efforts, including current searches for endowed chair-level positions in prostate cancer research. Also, the MUSC HCC has developed formal workgroup meetings in prostate cancer, bringing together clinical, basic, and population sciences researchers. At the end of the 10-week summer research period, each student prepares a brief written paper (6–10 pages in length) and gives an oral presentation, describing the research project that he/she worked on and preliminary and/or final research results. Given the short-term nature of the Training Program, not all Student Fellows see a research project to completion and/or publication. However, the Research Mentors give each Student Fellow a discrete research project to complete during the summer program. The Mentors also include the Student Fellows in all laboratory activities such as laboratory-specific journal clubs, maintaining laboratory notebooks and standard operation procedure manuals, research-in-progress meetings, research seminars, community engagement meetings, etc.

In addition to working with their Research Mentors, Student Fellows will actively interact with junior faculty, postdoctoral fellows, pre-doctoral students, and other scientists within each laboratory/research office. Beyond the scope of the Training Program, MUSC Research Mentors contact Student Fellows during the academic year after their summer research experience, and Student Fellows are asked to identify a mentor at their home institution to continue to promote their journey toward graduate school admission.

Results

As part of the evaluation of the cancer education training program, summative and formative data are collected. The summative data include the number of students who apply to graduate or professional school, make scientific presentations, publish peer-reviewed scientific papers, and enroll in graduate or professional school. Formative data include the perceptions of the program, as indicated in the Student Fellows' testimonials that are included in the Appendix.

Outcomes from Case Example 1. NIH/NCI P20 SC CaDRe Grant

As shown in Table 2, the P20 SC CaDRe cancer research training grant has led to numerous scientific presentations by the students who have participated in this funding mechanism. In addition, 3 (100 %) of the undergraduate Student Fellows who have participated in this training mechanism have taken a grant-sponsored GRE test preparation course, and 2 (67 %) have successfully enrolled in graduate school.

In addition to the training outcomes related to the Student Fellows, to date, the SC CaDRe has facilitated the award of two research project grants—R21 CA176135: Glycation as a Mechanism Promoting Cancer Disparity and R01 MD005892: Improving Resection Rates among African Americans with NSCLC, as well as an NIH/NCI Diversity Supplement to support an underrepresented doctoral student: 3P20 CA157071-03S1 SC Cancer Disparities Research Center in Prostate and Breast Cancer (SC CaDRe) Diversity Supplement.

Outcomes from Case Example 2. DoD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program

As shown in Table 3, the 24 undergraduate Student Fellows who have participated in the DoD SC Collaborative

Table 2 Academic outcomes of the NIH/NCI P20 SC CaDRe Grant

	2012		2013		2014		Total
	Undergrad (*N*=1)	Grad (*N*=1)	Undergrad (*N*=1)	Grad (*N*=1)	Undergrad (*N*=1)	Grad (*N*=2)	7
No. of scientific presentations given by Student Fellows	1	0	4	3	4	3	15
No. of publications by Student Fellows	0	0	0	0	0	1	1
No. of students who took the GRE test preparation course	1	0	1	0	1	0	3
No. of students who applied/applying to Graduate School	0	0	1	0	1	0	2
No. of students who enrolled in Graduate School	0	0	1	0	1	0	2
No. of students who applied/applying to Professional School	0	0	0	1	0	1	2
No. of students who enrolled in Professional School	0	0	0	0	0	1	1

Table 3 Academic outcomes of the DoD SC Collaborative Undergraduate HBCU Summer Training Program Grant

	2009 Undergrad (*N*=4)	2010 Undergrad (*N*=4)	2011 Undergrad (*N*=4)	2012 Undergrad (*N*=4)	2013 Undergrad (*N*=4)	2014 Undergrad (*N*=4)	Total 24
No. of scientific presentations given by Student Fellows	4	5	6	7	4	4	30
No. of publications by Student Fellows	1	1	0	0	0	0	2
No. of students who took the GRE test preparation course	4	4	4	4	4	4	24
No. of students who applied/applying to Graduate School	3	3	4	2	3	0	15
No. of students who enrolled in Graduate School	3	2	3	2	0	0	10
No. of students who applied/applying to Professional School	1	1	1	0	1	0	4
No. of students who enrolled in Professional School	1	0	0	0	0	0	1

Undergraduate HBCU Student Summer Training Program in cancer research have made 47 scientific presentations. All 24 Student Fellows (100 %) took a grant-sponsored GRE test preparation course, 15 (63 %) applied to graduate school, and 11 of them (73 %) enrolled in graduate or professional school. The remaining 9 Student Fellows (38 %) are in the process of applying to graduate or professional school.

Unintended Consequences—Outcomes from Other Leveraged Funds

In addition to completing the work of the P20 SC CaDRe grant and the DoD South Carolina Collaborative Undergraduate HBCU Student Summer Training Program, since 2011, the investigators annually have led the coordination of the Student Research Forum of the National Conference on Health Disparities (NCHD). The all-day Forum includes a poster session, oral presentations, a luncheon keynote speaker, and a roundtable discussion. The Forum also includes an interactive learning module presented by a National Library of Medicine staff member. In 2011, 54 students participated in the Student Forum during the NCHD in Charleston, SC. In 2012, 60 students participated in the Student Forum during the NCHD in Little Rock, AR. In 2013, 87 students participated in the Student Forum during the NCHD in St. Thomas, US Virgin Islands. In 2014, 66 students participated in the Student Forum during the NCHD in Long Beach, CA.

In addition to the Student Forum, since 2011, the investigators have annually contributed to the coordination of the Ernest E. Just Symposium held at MUSC each spring. Dr. Just was an early twentieth century African American embryologist who devoted his career to studying the early development of marine invertebrates.

The Symposium serves as a major vehicle to recruit underrepresented students to enroll in graduate studies at MUSC. The students receive a tour of MUSC while they are on campus for the Symposium and meet with MUSC faculty to discuss graduate research options. These faculty members could become their future research mentors. In 2011, 400 students participated in the Symposium, representing 17 different colleges and universities, participated in the Symposium. A total of 66 students from HBCUs in SC participated in the Symposium. In 2012, 297 students participated, representing 19 different colleges, and universities. A total of 91 students from HBCUs in SC participated in the Symposium. In 2013, 240 students participated, 67 of whom were from HBCUs in SC. In 2014, 394 students participated, 56 of whom were from HBCUs in SC.

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Discussion

The percentage of older adults in the population is increasing commensurately with the projected 45 % increase in cancer incidence rates [2]. Therefore, it is imperative that undergraduate research training programs are implemented to increase the number of underrepresented cancer-focused biomedical research scientists in the STEM careers. This "next generation" of cancer researchers will lead the way in developing discoveries to better treat the anticipated rising number of cancer patients in the USA.

This paper described the results of two Training Programs for underrepresented students. The first Training Program is funded by an NIH/NCI P20 SC CaDRe grant. The second Training Program, funded by the Department of Defense, is titled HBCU Student Summer Training Program. During the NIH/NCI P20 SC CaDRe and DoD-funded summer research programs, the Student Fellows receive didactic, twice-weekly instruction in the etiology of breast and prostate cancer, the genetic basis of cancer, the anatomy and function of the breast and prostate, controversies in breast and prostate cancer screening, and biostatistical and epidemiologic issues in breast and prostate cancer research, among other topics. The Student Fellows also gain hands-on experience working in the research labs/offices of leading cancer researchers in the basic, clinical, and population sciences at the Medical University of South Carolina (MUSC). In addition, the Student Fellows gain scientific presentation skills, which are required when they make presentations at local and national scientific meetings. The NIH/NCI P20 SC CaDRe and the DoD-funded summer research programs are federally funded programs that are conducted with institutional support from MUSC. This support allows the Student Fellows' mentors and the instructors in the didactic education components of the programs to participate at no charge to the grants. In this paper, case examples for each funding mechanism were presented.

The NIH/NCI P20 SC CaDRe and the DoD-funded programs are offered during the summer only. During the academic year, the Student Fellows are invited to participate in scientific research forums at MUSC. The funding to support the students' travel to MUSC to present their research is provided through the grants. Funds to support the students' travel to local and national meetings to present their research is generally provided by their home academic institutions. In addition, during the fall and spring semesters, many of the summer mentors work with their students on conference presentations and manuscript submissions. Much of this work is completed via email and teleconference.

The P20 SC CaDRe Training Program has contributed to an increase in students applying to graduate school by fostering an environment that employs the *triple-level mentoring strategy*. The triple-level mentoring strategy instills the value of keeping the pipeline alive. A major strategy in increasing the underrepresented researchers is to re-emphasize that minority researchers are expected to help aspiring student researchers to fulfill their purpose. The P20 SC CaDRe Training Program provides an opportunity for students to access mentors one-on-one and conduct cancer research. The one-on-one mentoring allows the Student Fellows to ask seasoned cancer researchers questions that they might be apprehensive of asking in front of other peers and the freedom to ask pertinent questions regarding graduate application and research tips can only benefit Student Fellows' progress. In addition, Student Fellows have the opportunity to feature the results at the HCC Annual Spring Research Symposium, Perry Halushka Student Research Day, and the Student Research Forum for the National Conference on Health Disparities. The Student Fellows' participation in symposiums allows them to interact with senior cancer researchers and their student peers and provides an opportunity to gain additional mentors, which could lead to future internships and/or research/grant-writing collaborations.

The Department of Defense HBCU Student Summer Training Program has provided underrepresented students with the opportunity to conduct prostate cancer research, gain laboratory experience, participate in journal clubs, interact with the Sea Island/Gullah SC population, and gain invaluable mentors. This experience will help minority Student Fellows realize the relevance of conducting research within underrepresented populations.

Although the two training programs that have been described in this paper may prove beneficial to academic institutions by demonstrating ways to increase the number of underrepresented cancer researchers, the data from the training programs present some limitations. For example, due to the relatively small number of summer training program participants, statistical analyses of the data were not conducted. However, the measurable outcomes collected from the DoD SC Undergraduate HBCU Student Summer Training Program track the number of Student Fellows who took the GRE, applied to graduate school, completed scientific presentations and publications, and convey that the majority of Student Fellows who participated in these mentoring, research programs are enrolled in undergraduate or graduate programs.

These measurable outcomes will assist MUSC and the HBCUs in applying for additional funding to maintain the summer research programs.

A second limitation is that both of the case studies that are described in this paper are federally funded cancer research training grants for underrepresented populations from HBCUs in South Carolina. Data from only one state were included in the analyses, and the Student Fellows are minority students from colleges and/or universities with a minority European American population. This could potentially limit the generalizability of the findings.

Despite some limitations, the training programs have laid the foundation for other programs to provide training to underrepresented students, with the ultimate goal of increasing the diversity of the biomedical workforce. For example, the investigators recently submitted a NIH/NCI R25E grant which aims to create an innovative, inter-institutional, 14-week cancer health equity course that will be combined with hands-on laboratory research training activities and career mentoring, provided by senior mentors. This new initiative is a collaboration of an academic medical university and three HBCUs in South Carolina. Promoting interest, career development, and commitment from the Millennial Generation (those born in the 1990s) to cancer biomedical research is a critical step to attaining health equity and improved health outcomes in SC and beyond. Additional funding initiatives will be needed to significantly enhance the biomedical workforce over the next several decades.

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Ethical Standards The manuscript does not contain clinical studies or patient data.

Conflict of Interest The authors declare that they have no conflict of interest.

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